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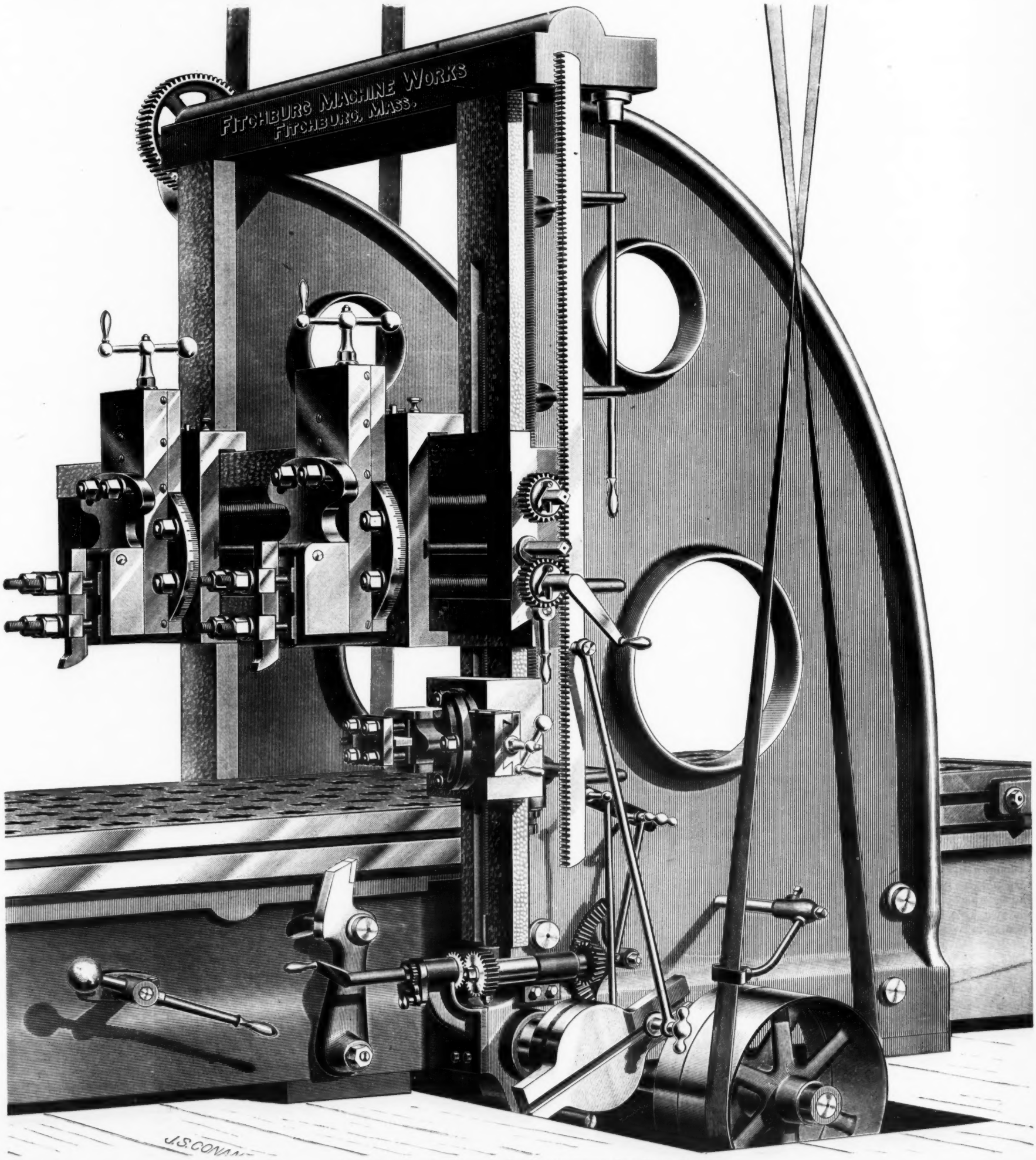


THE FITCHBURG PLANER.—FOR DESCRIPTION SEE PAGE 2.

The Fitchburg Planer.

The engraving on the preceding page represents a line of planers of various sizes up to 72 inches square, and to plane any desired length, built by the Fitchburg Machine Works, Fitchburg, Mass., the engraving being made from the 48-inch size. The designs of the planers built by this company have been recently improved in the line of present tendencies in machine tool building, the parts being considerably increased in weight, and all bearing surfaces made much larger than formerly. As will be noticed, the faces of the housings are made broad and the cross rail deep, to secure ample strength and rigidity, and all bearing surfaces, including that of the platen on the bed, are scraped by hand to a bearing. The cross-rail is secured to the housings by means of a device which is worked by the simple movement of a lever at the working side of the machine, which, of course, results in a considerable saving of time, and it is raised or lowered by power. An extra head is placed on the face of the housing nearest the operator, and this has an automatic vertical feed and can be fed at any angle by hand, the broad face of the housing giving it sufficient bearing to make its working entirely satisfactory and efficient.

The machine is furnished with only one head where desired, but where two are placed upon the cross-rail it is extended out at the back in the usual manner, so that one head can be run out of the way to allow the remaining one to cover the entire platen.

The motion of the platen can be reversed from the back of the machine as well as from the front, a lever being provided for that purpose. The feed mechanism and other points will be readily understood from an inspection of the engraving.

The Measurement of Power.

By J. J. Flather.

FIRST PAPER.

In designing a modern machine shop or manufactory, and in estimating the cost of power for its working plant, an accurate knowledge of the amount of power absorbed by the different machines is not only desirable, but essential to economy and efficiency.

If the power required is not known, the engine or motor provided may prove incapable of driving the work; or, on the other hand, the motive power may be largely in excess of that required; in either case there is an unnecessary expense—in the first case in remedying the evil, and, in the second, in the daily expenditure of fuel for excess of power.

So also in fitting up a factory, if a more accurate knowledge of the power required to drive machine tools were known, there would be a greater economy in running them. The writer has in mind a case that came under his notice a few years ago, in which a certain wood planer had its countershaft changed three times—different diameters of pulley, and different widths of belt, and finally a heavier countershaft being used—before it would work satisfactorily. Machines are largely belted by guesswork. If the pulleys guessed at are *nearly* large enough to do the work the workman stretches his belt to its utmost, and manages to run the machine by taking light cuts; if, however, the belt has a velocity and width barely sufficient to run the machine, and an ordinary cut will throw off the belt then, if split pulleys are not in use, a length of shafting is taken down and a larger pulley put in the place of the one which has shown itself to be insufficient to drive. Sometimes a greater width of belt and larger pulley both have to be resorted to.

Another case occurring in the writer's practice was where a 6″ belt running over a 36″ pulley at 120 revolutions per minute had been put in, and had been running for more than a year driving a room full of high-velocity machines used for covering magnet wire. Evenness of motion is specially desirable in this class of machinery, and yet, when all the machines were on, the shaft would vary from eighty revolutions per minute to its normal speed.

Chalk, rosin, or belt oil was in order every few days, and when the slip became too great the engine had to be shut down and the belt re-laced. This re-lacing was done by the use of clamps, and the belt finally became so taut that the increased friction on the bearings near the driving pulley kept the boxes and shaft constantly hot. This belt was a continual source of annoyance and expense, but, because it had been deemed large enough to furnish power for the forty or more machines in the room, no change had ever been made, and it had run for over a year in this same slipshod way.

A 9″ belt was put on, and no trouble was afterwards experienced, though it has now been running for more than three years. It is easy enough to remedy a defect like this, but prevention would have been better, and would have saved quite an item on the expense account. The knowledge of the power required to drive the machinery was wanting. The question arises: How can this power be estimated?

In the discussion of an inquiry as to the power required to drive machine tools, Mr. G. H. Babcock stated at a meeting of the American Society of Mechanical Engineers * that for a general rule in ordinary machine work we may calculate roughly that one horse-power is sufficient to drive machine tools necessary to keep ten men at work, but this, he adds, does not necessarily include shafting, engine, etc., nor blowers for foundry work.

Expressed algebraically this rule of thumb would be:

$$\frac{N}{10} = H.P.;$$

where N equals the number of men employed, or if we let $10 = C$, a constant, we have:

$$\frac{N}{H.P.} = C.$$

The above as it stands is of little or no value; in the first place C is too large, as will be shown by the following data obtained from a large number of representative machine shops; and, in the second place, the power required to drive the machinery varies between such wide limits, even in the same class of work, that separate values of C cannot be determined which may be relied upon as giving even a rough approximation.

Such a formula is of value only when C has been determined for two or more similar plants, and applied to another equipment working under similar conditions—and this indeed is rarely met with.

By a reference to the above table it will be noticed that two firms on exactly the same line of work—that of manufacturing machine screws—require a total horse-power such that the number of men employed per H. P. is in the one case 2, and in the other 0.62; or as 3 to 1—the small value of C in both cases is evidently due to the nature of the machinery, which is largely automatic, one man being able to feed several machines. A comparison of the values of C (obtained for total power used) of the well-known firms, Pratt & Whitney Mfg. Co., and Brown & Sharpe Mfg. Co., shows that the latter employ only 3.91 men per horse-power, while Pratt & Whitney employ 6.04; and yet these shops may be considered to belong to the same class.

Another comparison of two firms running about the same class of machinery is that of the Baldwin Locomotive Works, and William Sellers & Co.

Baldwins give a value of 1.64 for C per total horse-power, and Sellers & Co. give 2.93. If we deduct the power required to run the shafting in each works the values become respectively

$$C_1 = 8.20$$
$$C_1 = 4.87$$

A closer result obtains between the Pond Machine Tool Works, and William Sellers & Co. throughout all the data given. The percentage of power required to drive shafting is in one case 41 per cent., and in the other 40 per cent.; the values of C and C_1 are as follows:

	C.	C_1.
Pond Mach. Tool Works...	2.4	4.11
Wm. Sellers & Co.....	.2.93	4.87
Average.....	.2.66	4.49

These values are sufficiently close to enable one to deduce an approximate value for C and C_1 which would apply to either case, but when used in connection with other and similar shops the results could not be depended upon, even roughly.

Thus the average value of C, as shown above, is 2.66 per total horse-power; applied to Wm. Sellers & Co. this gives:

$$\frac{N}{H.P.} = C \therefore N = C \times H.P.$$
$$= 2.66 \times 102.45$$
$$= 273 \text{ men employed;}$$

Applied to Pond Tool Works:

$$N = 2.66 \times 180$$
$$= 478 \text{ men employed;}$$

in the former case N should equal 300, and in the latter 432. These results are only rough estimates, but are correct to within 10 per cent. of the actual number employed. If we apply the formula to Pratt & Whitney Co., manufacturers of machine tools, we obtain:

$$N = 2.66 \times 120$$
$$= 319 \text{ men;}$$

whereas we find from the table that 725 are employed.

Looked at from its most favorable standpoint by comparing those values for similar grades which most nearly agree, it will be seen that the formula is really of no practical value, and much less can it have any weight when looked at from an engineering standpoint.

A look at some of the results obtained from the data given may prove to be interesting.

It has been stated that ten is too large a value for the number of men employed per horse-power when applied to machine tools, even neglecting the power required to drive the shafting, etc.

The average value of C_1 obtained from table is 5.13, or say 5.0; while the minimum value is 0.833, the maximum being 10.25. It would be out of the question to apply the formula with the average value of C_1, viz.: 5.0, to either of these cases, nor is it practicable to apply any other value of C_1 either to determine the horse-power from the number of men employed, or *vice versa*, to obtain the number of men employed from the horse-power furnished.

It will be noticed in the sixth column headed "Per cent. of power required to drive shafting," that very wide differences occur. The maximum is that used by the Baldwin Locomotive Works, viz.: 80 per cent.—an extremely large factor—while the minimum given by J. A. Fay & Co. is only 15 per cent.; the average, 38.6 per cent., corresponds to that quoted by William Sellers & Co. within less than 1½ per cent.*

Mr. J. T. Henthorn, in a paper read before the American Society Mechanical Engineers, states that the friction of the shafting and engine in a print-mill should not exceed 19 per cent. of the full power. Out of fifty-five examples of a miscellaneous character which he has tabulated, 7 cases are below 20 per cent., 20 vary from 20 per cent. to 25 per cent., 15 from 25 per cent. to 30 per cent., 11 from 30 per cent. to 35 per cent., and 2 above 35 per cent., while the average of the total number is 25.9 per cent.

In machine shops Mr. Henthorn states the percentage of power required to overcome friction will exceed any given in the table for cotton-mill machinery, and will range from 45 per cent. to 50 per cent—this increase of friction being largely due to the interposition of countershafts employed to drive the smaller tools.

Mr. Barrus, speaking of this subject, quotes eight cases, the data of which were obtained from tests made by himself in various New England cotton-mills, in which the minimum percentage was 18, and the maximum 25.7, the total average being 22 per cent.

Mr. Webber thinks 16 per cent. of the total power of a mill is sufficient to overcome the friction of shafting and engine—10 per cent. for the shafting alone—but average practice does not appear to agree with Mr. Webber's deductions. There is no doubt, however, that a large percentage of the power now spent in overcoming the friction of shafting in ordinary practice could be made available for useful work if wider and looser belts were employed; or, what would have the same effect, if the belts were slackened and their speed increased.

TABLE I.

HORSE-POWER; FRICTION; MEN EMPLOYED.

NAME OF FIRM.	NATURE OF WORK.	HORSE-POWER. Total.	Req. to Drive Shafting.	Req. to Drive Machinery.	Pr. Ct. to Drive Shafting.	Number of Men.	C For Total H. P.	C_1 For Effective H. P.
Lane & Bodley.....	Engines and wood working machinery.....	58				132	2.27	
J. A. Fay & Co.....	Wood-working machinery	100	15	85	.15	300	3 00	3.53
Union Iron Works.....	Engines, mining mach'y..	400	95	305	.23	1600	4.00	5.24
Frontier Iron & Brass Works	Marine engines, etc.....	25	8	17	.32	150	6.00	8.82
Taylor Mfg. Co.....	Automatic engines	95				230	2 42	
Baldwin Loco. Works	Locomotives	2500	2000	500	.80	4100	1.64	8.20
W. Sellers & Co. (one department.)	Heavy machinery.....	102 45	40.89	61 56	.40	300	2.93	4.87
Pond Machine Tool Co.	Machine tools.....	180	75	105	.41	432	2 40	4.11
Pratt & Whitney Co...	" "	120				725	6.04	
Brown & Sharpe Co...	" "	230				900	3.91	
Yale & Towne Co.....	Cranes and locks	135 05	66.81	68.24	.49	700	5.11	10.25
Ferracute Machine Co.	Presses and dies.....	35	11	24	.31	90	2 57	3.75
T. B. Nord's Sons	Pulleys and shafting.....	12				30	2.50	
Bridgeport Forge Co..	Heavy forgings.....	150	75	75	.50	130	.86	1.73
Singer Mfg. Co.....	Sewing machines.....	1300				3500	2.69	
Howe Mfg. Co.....	" "	370				1500	4.28	
Worcester Mch. Sc. Co.	Machine Screws..... ..	40				80	2.00	
Hartford " " "	" "	400	100	300	.25	250	0.62	0.83
Nicholson File Co.....	Files, etc	350				400	1.14	
Averages	....	346 4			38.6%	818.3	2 96	5.13

The "American System" of Manufacture.

By B. F. Spalding.

IDEA OF INTERCHANGEABLE PARTS—UNCERTAINTY OF ITS ORIGIN—PUBLICATION IN FRANCE — DIFFICULTIES ENCOUNTERED — CHANGE IN CONDITIONS—WHAT THE "SYSTEM" IMPLIES—AMERICAN PRINTING TYPE — SUGGESTIVE CIRCUMSTANCES—"A MECHANICAL IDEAL"—ITS ELEMENTS — JEFFERSON'S VIEWS—ELI WHITNEY — COTTON GIN—GUN CONTRACT—EFFORTS OF GENIUS —RESULTS.

The fundamental idea of that complete system of manufacture which, by way of distinction, is designated the "American" system, and which consists in making the parts of machines so exactly to standard

*Trans. A. S. M. E., Vol. VIII.

* The writer believes that for shops using heavy machinery the percentage of power required to drive the shafting will average from 40 to 50 per cent. of the total power expended.

In shops using lighter machinery and which do their own casting the power percentage will be about the same as above; but for these latter shops, if the foundry work is done outside, the power required to drive the shafting, elevators, etc., will not average so high, the range being about 10 per cent. less, or from 30 to 40 per cent. of the total.

dimensions that the parts of one will interchange with the parts of another, cannot with entire confidence be claimed by any country or period. It is not known where or when it originated, but it can be clearly shown that in America it was first demonstrated to be practical.

It is known that the idea that the parts of machines might be so accurately made that similar parts would interchange, was definitely promulgated in France as long ago, at least, as in 1715. The advantages of such a system were clearly discerned, but the attempt to put it into practical operation proved that, with the then existing facilities, the work could not be done with sufficient accuracy, at a price which would be remunerative to private manufacturers, or which, on government work, it would be expedient to pay; the advantages gained not being great enough to offset the additional expense.

It is singular that so great a change should be brought about in manufacturing conditions. At the present time the paramount advantage of the system is that it cheapens the cost of production, but it was thought at that time that the greatest benefit would be derived from the facility of repairing damaged muskets, which was an industry which the wars of Louis XIV. had forced into prominence. It was not until the American experiment was practically in operation that its capability of reducing cost was realized. It was not until it had become a proverb at the national armory: "It is just as easy to do work right, as to do it wrong," that standard work could be done without extraordinary pains and consequent expense. This end was accomplished by the use of set tools, which produced the same effect upon every piece submitted to their action, making all alike.

The term "interchangeable system" implies a great deal more than that one part of a structure will take the place of a similar part of a like structure, for it holds that the parts must be of such a nature as require a degree of close fitting, which, without exact machining, would require skillful hand work to accomplish. Otherwise than this the germ of the idea was latent in the first font of movable printing type that ever was cast, whether in China or in Germany. The casting of pieces from the same patterns must have produced a certain degree of uniformity also in other work.

In America, for instance, Christopher Sauer printed the first Bible for the European population, in 1743, in the German language. (Elliot's Indian Bible was printed in 1663.) Sauer had more time than money, and rather than import the type, he made them himself. (The old anvil on which he forged the matrices, was still shown in Germantown in 1860.) He cast several fonts of these type, and printed his Bible with them. It is very evident that the idea of interchangeability is the fundamental principle of movable type. And Christopher Sauer not only cast type and printed Bibles, but he carried on a business in making "jamb stoves" of cast-iron. As these came from the sand molded from the same patterns, vague ideas of interchangeability must have floated in the air of the casting-room, as promiscuously as the dust motes which showed themselves in every fugitive sunbeam.

It was so everywhere. The processes of manufacturing, casting in molds, forging in dies, drilling more than one hole with the same drill, everything which produced two pieces, or performed two operations alike, was loaded with suggestion of the reduplication of parts. If there can be found no mention of the idea, or of the fact that it was in general or partial use, such want of notice can only argue, at most, that it had not been observed by any one who was sufficiently interested to describe it. Plants grew before Linnæus pointed out their analogies.

But with all these circumstances must be assembled the fact for consideration, that the making of rough work, which does not require close fitting to make one part go in as well as another, does not by any means fill the measure of the idea of the interchangeable system. Because one of Sauer's stove pokers would poke the fire in one stove as well as in another, that by no means uncommon faculty of adaptation, conveys no more suggestion of the intrinsic principle of the system than the pyramidical assertion that one brick of a building will interchange with another. The statement might be ridiculously true, but such interchangeability has been known from the time the first stone wall was laid, and is not closely allied, in any sense, with the system, the practicability of which was first demonstrated by American mechanics, using American machinery, designed, set, and operated for this specific purpose.

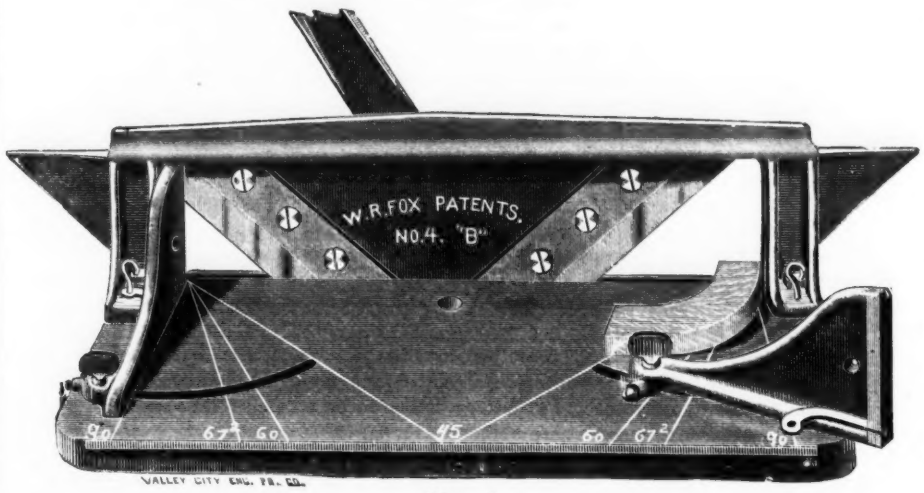


Fig. 1.

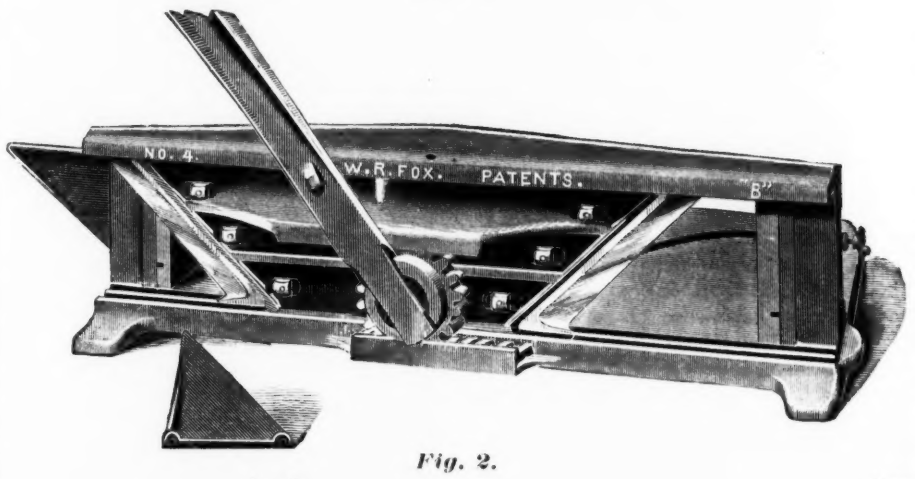


Fig. 2.

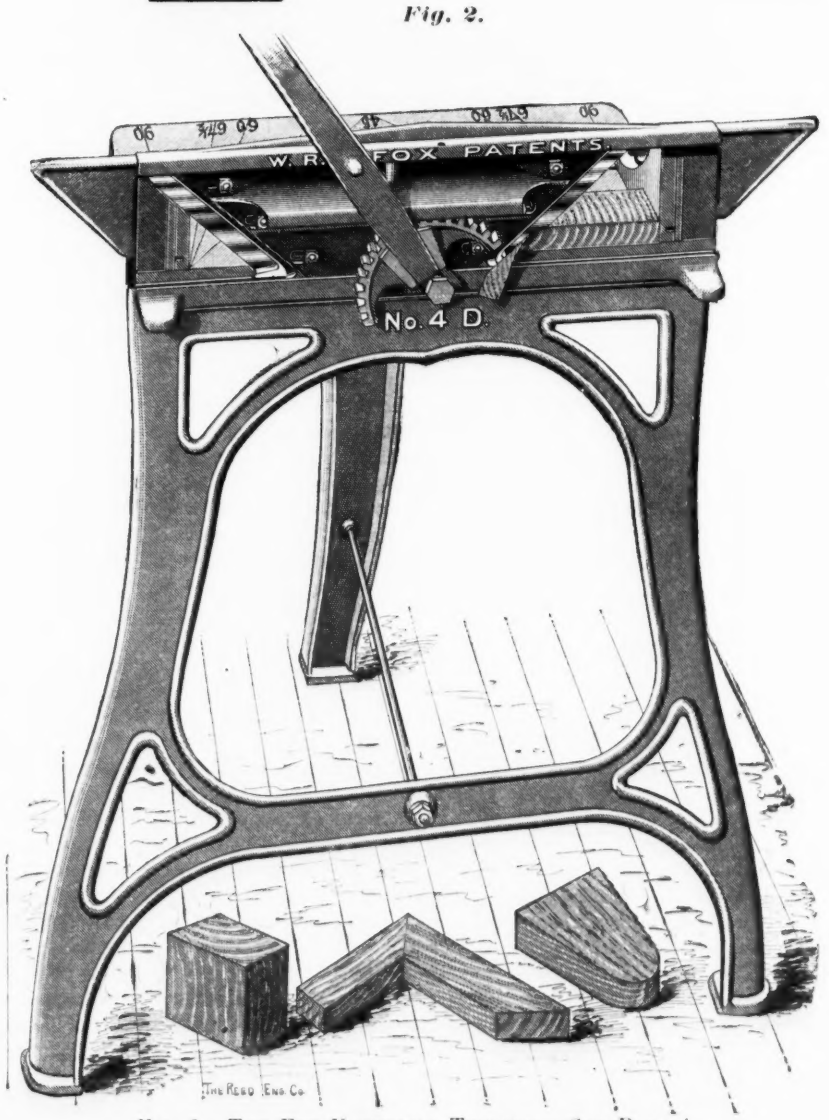


FIG. 3.—THE FOX UNIVERSAL TRIMMER.—SEE PAGE 4.

"The Rise of a Mechanical Ideal," is the very appropriate title which Charles H. Fitch gave to an article he contributed to the *Magazine of American History*, June, 1884. The "mechanical ideal" is the perfection in manufacturing, which succeeds in making articles uniform, in respect to size and shape, which is the essential thing in interchangeable work.

Mr. Fitch had the best of opportunities to inform himself upon this subject, as he was the special census agent, appointed to report in 1880 upon the fire arms industry, in which the multiproduction of similar parts had first been carried out to practical results. It would be derogatory to the traditions of the craft, as well as absurd, to suppose that this ideal of mechanics is of modern conception. Among the first ideas which the old masters endeavored to instill into the minds of their apprentices, was the desirability of attaining to such a high degree of skill as would enable them, when occasion required, to make two things alike. That tradition still remains. There have come down to us, from all times, specimens of the handicraft of mechanics, which attest, beyond doubt, that workmen have always existed as skillful in the use of tools, and as capable of performing the manual operations of producing exact and accurate work, as any that are now living.

The rise of the mechanical ideal, its progress and actual materialization, depended upon, and required the accumulated engines, devised and perfected by inventive genius during ages of time, and when the means for producing the desired result had assumed shape, they were recognized, brought together, each set to its appropriate place, and made part of the system, by a man who had impressed upon him the capabilities of each, by close observation and long training in their use.

Thomas Jefferson was forcibly struck with the novelty of the idea when it was first presented to him. In 1785, in a letter from Paris to John Jay, and afterwards in one to the Governor of Virginia, he mentioned a valuable improvement, which he had learned had just been made in the manufacture of muskets in Paris. The French government had approved of it, and was then establishing a large manufactory to put it in execution. He described it as consisting "in the making of every part of them so exactly alike, that what belonged to any one might be used for every other gun in the magazine." At time of writing, it had only been applied to the manufacture of locks, but was soon to be extended to all parts of the gun. The parts were to be forged in dies which would originate uniformity in them, and this was to be maintained, continued and improved upon, as they passed through various stages to completion.

This embodies, as far as may be done by words, the whole scheme of interchangeable parts, but it is only of importance as being the first recognition of such a project by an American writer. It did not amount to anything in France nor in this country, until the machinery had been developed which made it feasible.

Eli Whitney had some acquaintance with Jefferson, and Jefferson was so interested in mechanical operations (he was the inventor of a plow and a wheelbarrow) that he kept himself posted in all that was going on. He must have been aware of the work done by Sir Samuel Bentham in England in the latter part of the century. Sir Samuel had caught on to the requisites of the interchangeable system, so far as to classify the operations according to their nature; filing was filing; and drilling was drilling; and it was not necessary that one man should both drill and file. This is a great feature, and in addition to this he had devised and constructed several duplicating machines for working wood.

Whitney's intercourse with the public men of the nation, in his efforts to get possession of a monopoly of the cotton business, frequently brought him in contact with them while endeavoring to secure their influence. His original application for a patent on his cotton gin had been made to Jefferson, then Secretary of State, who promised to grant it as soon as the model was lodged in the patent office, and the patent consequently issued in March, 1794. This was a wire-tooth gin; Hogden Holmes invented the saw-tooth gin, and obtained a patent for it in 1796.

Whitney's partner, Miller, was the husband of General Greene's widow, and Whitney wrecked his fortune, and probably hers also, in lawsuits, which were decided against him. He was unable to control the requisite capi-

tal to carry out his cotton speculation, but having made available acquaintances with the public officers, he succeeded in getting a contract for fire-arms from government, although it was a business of which he was ignorant. He was a Yankee schoolmaster by profession, and his knowledge of mechanics had been gained while a boy, in pounding out nails by hand.

It is quite probable that he formed the scheme of making the guns he contracted for, on the interchangeable principle. He may have become acquainted with this through the interesting conversations he had with Mr. Jefferson upon mechanical matters, and that he sanguinely anticipated that the adoption of this system would compensate for his ignorance of the art of gun making is quite probable.

He took a contract in 1798 for 10,000 stand of muskets, under the stipulation that they should be completed in two years. It was an instance of the same kind as that to which Prof. Thurston called attention, a short time ago, where a person undertook a task for which his education had not prepared him. But here is where the genius of the man shone forth in its greatest luster; he educated himself, and at the end of the two years, although he had not succeeded in making guns, he had devised many of the tools which he used in the eight following years, which it required to fulfill his contract.

In Olmstead's Memoirs of Whitney, it is stated that he contrived by machinery to "make the same parts of different guns as much alike as the successive impressions of a copper plate engraving. Mr. Fitch observes, "Whatever ingenuity Whitney may have exhibited in tools, of which no account is preserved, the fact remains that in 1815 his methods were still rude, and not markedly in advance of his contemporaries. Interchangeability may have been attained by him in sample locks and guns, but it cannot be gainsaid that it was not a feature of his ordinary manufacture." As far as that goes, it may be said that the same thing had been done in France, a century before; sample locks and other parts of guns had been made to interchange in 1717, but it had not been found to be practicable to carry out the project on a commercial scale. The necessary tools for making it a success had not yet been invented. It was impossible to rear the system upon an enduring foundation until machines were accessible to the manufacturer, which would assure exact duplication in combination with economical production.

In another paper I will try to show the progress of the system, and its first successful development.

The Fox Universal Trimmer.*

We give on page 3 some illustrations of the latest forms of trimming machines made by the Fox Machine Company, of Grand Rapids, Mich.

Figs. 1 and 2 give front and rear views of what they call their No. 4 "B" machine, in which some improvements have been introduced, especially in the arrangement of the gauges by which they are pivoted upon the upright portion of the frame in such a manner as to be very firmly supported in all positions, and so as to secure the best possible action of the knife at all angles. In the present machine a link is introduced, to which the gauge is pivoted, and by which it is guided in turning it about to different angles. The machine has also been lengthened out, admitting of the use of a longer carriage. Provision is made whereby both the upper and lower slides are lubricated simply by putting oil in an oil-hole at the top of the frame. Lengthening the frame in this way also prevents the possibility of chips falling into the lower rack and interfering with the action of the pinion.

Fig. 3 shows the No. 4 "D" machine, which is similar to the other, but larger, and stands on legs of its own instead of being placed on the bench. In this machine, as will be seen, only one rack is used, and that is so placed that chips cannot get into it. These machines are being received with great favor in pattern shops and other places where the finer kinds of woodworking is done.

* See cuts on page 3.

The Mechanics' Fair at Boston.

One of the most venerable institutions in this country of new things is the Massachusetts Charitable Mechanic Association, which was organized in Boston in 1796, and has been holding exhibitions of mechanical products since 1837. Though the word charity occupies a very prominent place in the title of the association, charity was not the prime object in its organization, but it was simply at the outset an organization of employing mechanics for mutual benefit and protection—concerted action looking to the return of runaway apprentices, for instance, etc.

At any rate, the association has prospered, and now owns a large and good building, in which its fairs are held. Almost every imaginable kind of manufactured goods is to be found here from shoe blacking and "natural" mineral waters, to steam engines and watch tools and those who have had opportunities to compare the exhibition of this year with former ones, say that in the line of machinery the present one excels.

One of the first things, perhaps, which wil attract the attention of a mechanic who enters by the main entrance, especially if that mechanic is one who has done much traveling, is the display of a maker of steel trunks. A number of these are shown, most of them new and bright (with paint), but one just as it has come from various engagements with the expert baggage smashers found upon our American railroads. After an experience of some four years, during which it has traveled many thousands of miles and been in one or two wrecks, it is only dented here and there, and it looks as though something had been found which might prove a satisfactory substitute for the sole leather, which up to this time is the only thing found that will, in the words of the vernacular, stand the racket. A mechanic is apt to wonder, however, why it is necessary in building these trunks to make them of so many separate pieces of sheet steel, and then rivet them together, and if a little missionary work by some of the builders of drawing presses would not result beneficially.

Most of the machinery, especially that which is in operation, is on the basement floor; that on the first floor which is apt to attract the attention of the machinist, being chiefly small tools, such as the exhibit of A. J. Wilkinson, and the Faneuil Watch Tool Co., which has some glass cases filled with their machinery for the manufacture and repairing of watches, and which, so far as can be judged from the outside of a glass case, is admirable.

On this floor also are found the fittings and supplies used in the engine-room, etc. The American Steam Gauge Co. having an extensive exhibit, and the Mason Regulator Co. also having samples of their various products, which, on account of their novelty and excellent workmanship, attract much attention. The most unique and striking thing to be found here, however, was, at the time of our visit, secluded from the general public by a white cloth, which covered it up and made it resemble an equestrian statue just previous to the ceremony of unveiling. What the cloth conceals in this instance, though, is an articulated skeleton, which is seated upon the saddle of one of Sterling Elliott's "Hickory" bicycles, and having the feet attached to the pedals, and the hands to the handle bar in such a way that, when the wheel is made to revolve by some small friction wheels beneath the platform upon which it stands, the effect is quite "realistic," and, as may be imagined, much attention is attracted to it, especially from wheelmen and physicians. Others whose attention had been attracted to it had, however, concluded that it was a spectacle calculated to give a dangerous shock to the nerves of some people, and especially of women; hence the enveloping white cloth, which was preventing some other people with nerves not so easily shocked from studying anatomy, and the bicycle as a mode of motion. But whether draped or undraped, it is no doubt proving an effective advertisement for our machinist humorist.

On this floor also may be seen (and handled) a small model of the Robinson radial car truck, which is so arranged that every axle under a car is automatically kept in a line, which radiates from the center of the curve around which the car may be passing, the axles being parallel to each other only when on straight track, and the grinding of flanges, which takes place on curves with trucks constructed in the ordinary manner, is entirely avoided; the little model showing that sharp curves are passed over with scarcely a perceptible increase of friction. The truck has been adopted by the West End system of street railways of Boston, and by the Thomson-Houston Electric Co. A full sized truck, such as is used under a street car, is shown on the basement floor. It is controlled by the Robinson Radial Car Truck Co., of Boston.

As would be expected in an exhibition of machinery in Boston, a large share of that shown in operation in the basement is for making shoes, most of the more important operations involved in the manufacture of shoes being shown.

Quite the most attractive thing in the way of an engine, considered from the standpoint of its novelty, is the Merrill hot air engine, shown in operation by the Woodbury, Merrill, Patten & Woodbury Air Engine Co., of Boston. This engine would be supposed from its appearance to have four vertical cylinders, the pistons of which are attached by suitable connections to walking beams. It is found upon investigation, however, that only two of the cylinders are really such, or at least there are only two that do the actual work, the other two being more properly air pumps, the pistons of which are driven from the crank-shaft, and which serve to circulate the same body of air alternately over cooling surfaces composed of copper tubes filled with water and woven wire netting, and the heated surfaces by which its temperature rises and falls between 120 °F., the coolest, to 600°, the hottest. The engine appears to work very nicely, and, by reason of its novel construction, is examined by a great many people. Some considerable headway, it is claimed, is being made in introducing these engines, and the results of a test are published by the well-known mechanical engineer, Geo. H. Barrus, showing that the engine tested developed an average I. H. P. of 31.18, and an average brake H. P. of 19.92, coke being the fuel employed; the consumption of this, after normal working conditions were attained, being 1.54 pounds per I. H. P. per hour, and 2.37 pounds per brake H. P. per hour. At the same time Mr. Barrus calls attention to some sources of loss that had been overlooked by the builders, and which, when remedied, would, he believed, reduce this consumption to one pound of coal per I. H. P. her hour.

Among the other unique engines is to be seen the Kimble, made by the Kimble Engine Co., of Kalamazoo, Mich. It has an oscillating piston attached to the upper side of a shaft, which extends through from side to side of what would be the cylinder of an ordinary engine, but which in this case is a fan-shaped box in which the piston rocks back and forth, steam being admitted by an oscillating valve above it, the motion of this valve being controlled by a shaft governor. A crank-arm at the end of the oscillating shaft moves the connecting rod without the intervention of a crosshead, and we thus have an automatic variable cut-off engine of 5 horsepower, occupying a floor space 17x26 inches.

Another engine which attracts much attention is called the Ulrich, which is made by the engine department of the Hill Machine Works, of Florence, Mass. This is an oscillating engine, the one shown being called the duplex, intended particularly for hoisting purposes, and remarkable for the great facility with which it can be controlled and reversed by the movement of a lever.

An Armington & Sims engine, 10½x12, is driving several Thomson-Houston dynamos used for lighting. This engine runs quietly and steadily at a speed of 294 revolutions, and drives through the medium of friction gearing made by the Evans Friction Cone Co., of Boston, who, among other things, have in operation a pair of friction bevel gears, which, instead of being plain cones, are stepped, and appear to be doing their work here very satisfactorily, transmitting motion from one shaft to another at right angles.

A Westinghouse compound engine was, at the time of our visit, just being set up, preparatory to driving a part of the shafting.

The Wrought-iron Casting Co., of Boston, Mass., successors to The Mitis Wrought-iron Casting Co., show a number of specimens of their castings of wrought-iron, which are admirable, whether in the rough state as they come from the mold, or finished, as is the case with one which is regularly made for the Thomson-Houston Co. Some of the things claimed for these castings are that their strength is the same in all directions, which, of course, is very advantageous for many purposes, and the magnetic capacity of the metal has been found to exceed that of forgings, making the castings especially well adapted to electrical work, aside from the fact that they can be cast in forms not possible to forge, are true to pattern, and can be welded and worked the same as forgings in every respect.

The Akron Iron Co., of Akron, and the Falls Rivet and Machine Co., of Cuyahoga Falls, Ohio, have their exhibits combined, the most notable feature of which is perhaps an unusually large wooden pulley. It has a hub of cast-iron, composed of two parts, between which is fastened the disk, made up of glued strips of wood, to which is attached the rim, made in the same manner. The hub is bored for a 5½-inch shaft, and the pulley is 120 inches diameter, and 28-inch face. The man in charge would not say that the wooden pulleys were thought to be better than the steel rim pulleys made by the same concern, but said that "some people would have a wooden pulley."

A machine which attracts the attention of the pattern makers particularly, is shown in operation by the Adjustable Saw Table Co., of Fitchburg, Mass. The machine was gotten up by a practical pattern maker, especially for the work that a pattern maker has to do on a saw table. Several saws are carried on separate arbors, these arbors being mounted in a frame, which is revolved in a vertical plane to bring any desired arbor into line with the driving shaft, with which it can then be connected by a clutch which combines the friction and interlocking principles in such a way that it can be thrown in while the driving shaft is at full speed, without shock, the saw arbor being driven by friction until it attains full speed, when, by a further motion of the lever, the clutch interlocks and drives positively. The table is divided into two parts, one of which always remains level, while the other may be tipped at any desired angle by turning a hand-wheel, thus permitting work to be sawed square at any time without disturbing the angular adjustment. Besides these, the machine has other features which make it especially attractive to those for whom it is intended.

The number of tool builders represented is not great, and situated as the exhibits are, surrounded by machinery which is in its nature very noisy, such as looms, for instance, places the builders at some disadvantage, and makes the effort to discuss the features of the machines with those in charge of them a task of some difficulty.

This is the more to be regretted, as there are a number of things shown in this department which any one at all interested in tools is very apt to want to talk about with the attendants. The major part of the exhibit of the American Tool & Machine Co., of Boston, consists of other things than tools, there being a belt remover of novel design, by which the belt is first loosened between the pulleys, and then by the turning of a hand-wheel lifted off from one of them without being moved to one side, rollers mounted in a frame pivoted on the shaft being interposed between the belt and pulley.

They also show a belt controller for dyna-

mos, by which they are started or stopped at pleasure without countershafts. The tools shown are a double-head valve miller for finishing the hexagonal portions of globe valves, and a turret-head lathe with chasing attachment for brass work. This lathe has a new feature in the way the head is secured to the bed, that portion of the bed to which it is attached being planed on an incline, and the bottom of the head inclined to correspond, so that moving the head slightly towards the foot of the lathe the spindle is raised, so that by this means it can be adjusted vertically, means being provided by which the movement of the head can readily be accomplished.

The vertical milling machine illustrated in our issue of October 25, made by the John Becker Mfg. Co., of Boston, is shown in operation running at a very high rate of speed, and doing its work with a smoothness and steadiness which is quite remarkable. No one witnessing its operation will be disposed to doubt that, for the work intended to be done by it, it is a very efficient machine.

The Chandler & Farquar Machine Tool Co., of Boston, have a full line of the standard machine tools, such as drill presses, lathes, planers, shapers and turret-head Fox lathes made by the Lodge & Davis Machine Tool Co., of Cincinnati.

By far the most notable exhibit of machine tools, however, both as regards its extent and the new things shown, is that of the Brown & Sharpe Mfg. Co., of Providence, R. I. Twenty machine tools are included in this exhibit, besides a very full line of other machines and small tools made by the company and by the associated company of Darling, Brown & Sharpe. Seven of these machines are milling machines of various types, universal and plain, and there are four grinding machines, including the No. 2 improved, recently illustrated in these columns, two surface grinding machines, and the universal cutter and reamer grinder. Then there is an automatic gear cutting machine which is kept at work all the time; four screw machines of different sizes, one of them the new automatic machine, which is kept at work making the knurled nuts which are used on the top of their clippers. These nuts being short, so that the bars of stock do not need to be frequently renewed, and involving quite a number of operations, including drilling and tapping the hole, and knurling the upper portion of the outside surface, make an excellent job to show the capabilities of the machine; and to say that the machine does the work admirably is to state the case very mildly.

It works very rapidly, every moment of time almost being made use of for one or more operations upon the nut, one tool being no more than withdrawn until another is presented, and the work goes on practically without intermission. Though working very rapidly, it is noticeable that there is absolutely no jar or shock, and to see the machine work one is impressed with the idea that, if the tools could be made to stand it, the machine would just as easily work at twice the speed. It constitutes, we think, one of the best examples of modern high-class machine designing, and, as a mechanic who had stood and watched it in operation for some time said: "If that machine had one or two more parts it would talk French." The machine differs entirely from any other screw machine, either ordinary or automatic, with which we are acquainted, the most striking departure from the usual practice being perhaps the placing of the turret at the side of the turret slide, and so that it revolves in a vertical instead of in a horizontal plane, the shaft upon which it is mounted passing across the turret slide and carrying at the opposite extremity the mechanism by which it is rotated. The universal grinding machine is also belted up, so that its operation can be witnessed by any one who desires it.

The small tools which have been selected for exhibition are such as are used mainly in connection with the machines, such as gauges, milling cutters, micrometer calipers, of which seventeen different styles are shown, and a large variety of steel scales. Not the least interesting feature of the exhibit is a stand upon which is mounted an assortment of gears so connected as to be turned by hand that their action may be studied. The gears are sufficiently large in diameter and pitch (the latter being, to speak from memory, from 6 to 8 diametral) so that their action may readily be observed. The shaft on which the hand-wheel is placed passes through the entire system, and the gears which are driven from it are arranged in three groups.

The first of these consists of two spur gears which drive two bevel gears; next there is a worm on the shaft which drives a worm-wheel, which in turn drives a pair of skew bevel gears, a portion of one side of the worm-wheel being cut away by a milling cutter to show the shape of the teeth at the middle of the face of the wheel. Finally, at the other extremity of the shaft is a spiral wheel having its teeth at an angle of 45°, this driving a similar gear which is on a stud which stands above and at right angles to the shaft; another stud being provided to which the last-mentioned gear may be changed, this stud standing parallel to the shaft, so that it is seen how a pair of these gears may be arranged to work either way at pleasure. Then to complete the system there is below the gear which is on the shaft, a plate having square grooves cut in its upper face parallel to the center line of the shaft, at right angles to it and at 45° to it in both directions, all these grooves crossing or intersecting each other at the center of the plate, which is under the center of the spiral gear on the end of the shaft. Two racks are provided having on their under sides tongues to fit the grooves in the plate, and one of these racks is of the ordinary form with teeth cut square across, while the other has them at an angle of 45°. Either of these racks, when placed in the groove that brings its teeth into line with those of the gear, will easily revolve the entire system, and that, too, with a motion that is remarkable for its smoothness and freedom from friction. It is a very interesting feature of the exhibit, and, so far as we know, is the best device yet made for showing what can be done by cut gears.

The samples of work done on the screw machines made by the company are also interesting, and, to those unacquainted with the capabilites of screw machines, instructive as well, since many things are shown here just as they came from the machines, which it would hardly be thought by the uninitiated to be possible to produce in that way. The exhibit, taken as a whole, is the most complete and comprehensive single display of tools that has been shown in this country for a long while, if ever, and is especially interesting as showing the very latest and highest achievements of the tool maker.

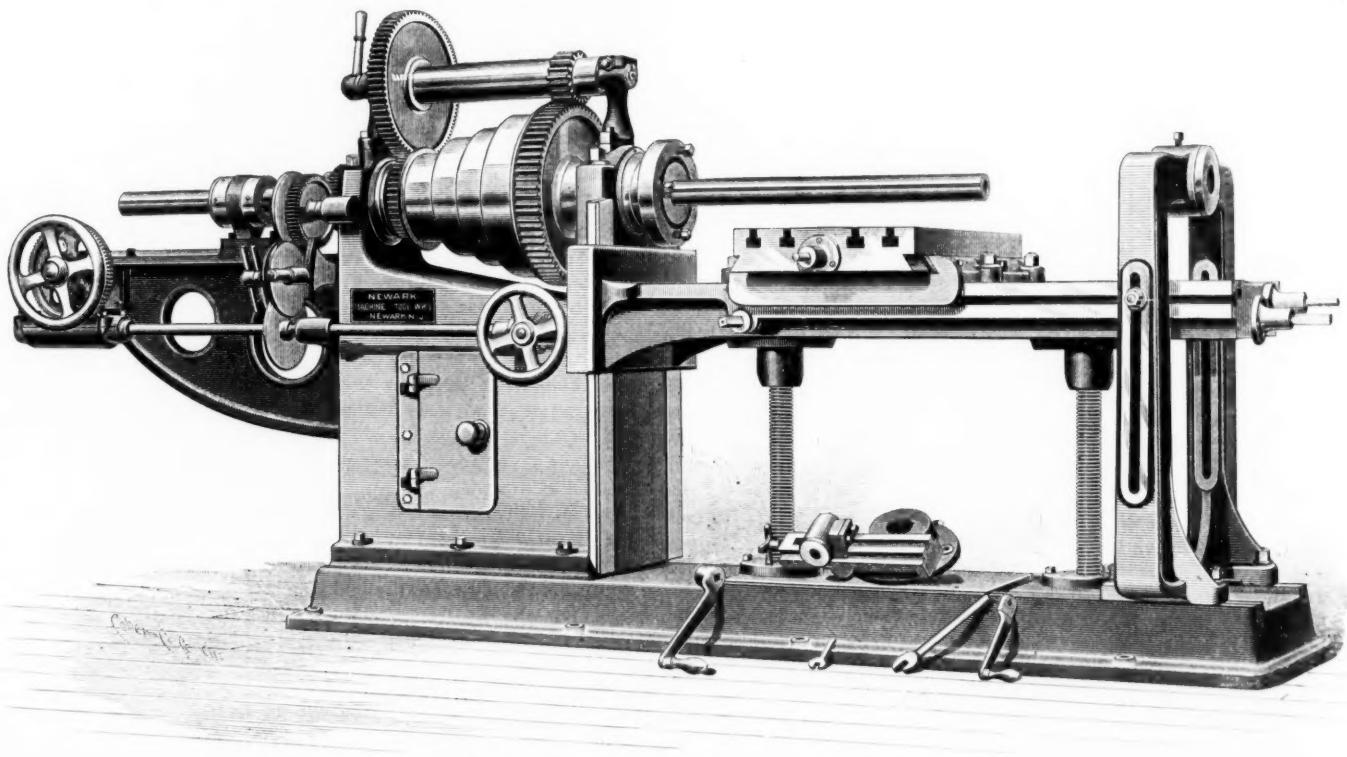
Horizontal Drilling and Boring Machine.

We give on this page an illustration of a horizontal boring machine, which, while it is of the general type that has become familiar in the shops where they go in for improved facilities for doing work, yet has some features connected with its details which are original, and, we think, of interest. To begin with, the feed arrangements have been put on the opposite side of the machine from where they are usually put, thus bringing the operator into the same position with regard to the cone pulley, and the various hand-wheels and levers by which the machine is operated, that he occupies at the lathe; which is believed to be an advantage, since the lathe is the standard machine tool with which all machinists are familiar. This machine is not the only one in which the parts are so arranged, but the usual practice is to place them on the other side, so that the cone pulley and hand-wheels come at the right of the operator, instead of the left, as they do on the lathe.

The feed details have, it is believed, been reduced to the simplest possible form, considering the ends attained by them, *viz.*, a great range of feed with any required number of variations, and which can be changed either in rate or direction with the greatest facility. For securing the changes in the rate of feed the Sellers friction disks have been adopted, the materials chosen for their construction, and the method used for regulating the pressure of the central disks upon the upper and lower disks, insuring their satisfactory operation under the heaviest duty. Any rate of feed from $\frac{1}{50}$ to $\frac{1}{4}$ inch is instantly available by the simple movement of a lever. These friction disks drive a worm shaft which extends to the rear of the machine, and is there provided with two worms—one right and the other left-hand, these worms being cut upon a sleeve which is fitted to the shaft, and can be moved along to make either of the worms engage with the wheel, which is an ordinary spur gear. Thus the feed may be in either direction at will, and a cutter after passing through a bore can be run back for the finishing cut when desired, without disturbing it in the bar. The clamp by which the bar is secured to the feed slide grips it by friction only, instead of having holes through for a pin, and thus it can be gripped at any point instead of a limited number of points only.

The table can be raised or lowered from the side or end of the machine, as may be most convenient, and the platen has the usual movements in either direction, in addition to which a platen is furnished where desired, which can be turned around on the table to any angle. Special pains have been taken to make all the parts of the machine amply heavy for the duty they have to perform, particular attention being given the yoke which supports the outer end of the bar, since weakness of this part of the machine is quite too common, and where it occurs greatly limits the capacity of the machine.

Four sizes of the machine are built, all being based upon the diameter of the bar they are intended to use, as this ultimately of course limits the capacity. The machine from which the engraving is made is called the "C" machine, and has a three-inch bar with a table five feet long. It will swing over the platen three feet three inches, and over the table four feet. The platen is thirty inches long, seventeen inches wide, and has a motion across the bed of twenty-four inches. The machine measures over all ten feet nine inches, and weighs 7,500 pounds. It will bore holes up to eighteen inches diameter. Other machines of the same design are built, having bars four, five and six inches diameter, and with other parts in proportion, the largest machine weighing about 17,000 pounds. The squaring attachment shown is furnished with each machine, and the swing or the size of platen or table can be altered to suit special requirements.



HORIZONTAL DRILLING AND BORING MACHINE.

Our attention is called by James Duncan to a small circular, in which the announcement is made that the Lowell course of practical lectures, which we referred to last year, will be continued this year. These lectures are given at the Wells Memorial Building, 987 Washington street, Boston, and are free to all. They embrace such subjects as Practical Carpentry, Practical Electricity, Steam and Steam Engine. They are not historical treatments of the subjects, but deal with the practical details. Mr. Duncan, who is a steam engineer, and who has attended the previous lectures, is enthusiastic over the advantages to be derived from attending them. Edmund Billings, 987 Washington street, will give information about securing tickets.

A correspondent would like information in regard to the building of a small machine shop 35x75 feet. Can any of our readers help him?

History of Attempts to Determine the Relative Value of Lubricants by Mechanical Tests.*

AN ADDRESS BY PROFESSOR JAMES E. DENTON AT THE INDIANAPOLIS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Without further extending our list of the different classes of service, let us face the question.

What is the cause of the wide differences of opinion to be found in practice which testify to the existence of differences of lubricating value among oil, etc.?

The answer is that all these differences are connected with the overheating of bearings—with the creation of hot boxes. Oils of the same appearance, fluidity and general qualities, do certainly differ in their ability to lubricate bearings which are overheated, *or, rather, in their ability to reduce the frequency with which overheating occurs in a given bearing or set of bearings.* A striking instance which has been brought to my attention is the case of some large engines which, having been using lard oil for the lubrication of their crank-pins, without trouble, changed to the use of a mixed oil of unknown composition, but which was apparently identical in lubricating ability. After using the new oil for a few days, excessive overheating occurred, and the crank-pins were badly mutilated.

Longitudinal grooves upwards of six inches long, one-quarter of an inch in depth, and one-half as wide, covered the surface of the pins. The first idea was, naturally, that the new oil contained some corrosive ingredient, but close examination showed this not to be the case. Experiment upon the mechanical oil-testing machine with smooth journals and brasses showed no difference of lubricating value, as we have seen is always the fact in the foregoing remarks. All kinds of journals, as regards openness of structure, were tried with the two oils, as, for example, journals of steel and of coarse iron, with the grain parallel to the axis of the journal. There was no difficulty in obtaining as satisfactory coefficients of friction with the new oil as with lard oil, with the bearings in ordinary conditions of smoothness, and at ordinary temperatures. But upon creating an abnormally high temperature, such as 400° Fahr., by running the oil-testing machine at a sufficiently high speed to prevent the natural radiation of the bearing surfaces from maintaining the temperature at ordinary limits, it was found that the new oil which had given the trouble gave a steadily increasing friction, which finally wore away the brasses so as to clog the oil holes and stop the supply of oil. It was then decided that the differences in the two oils must arise from a generation of heat due to accidental cutting caused by the constant and inevitable wear of bearings under heavy pressure. Accordingly, test journals were artificially abraided by scoring them with a ragged-ended steel point forced against the journal through a hole in the brass. The result was that the friction increased above the amount which would naturally maintain the bearings at ordinary temperatures.

But while such increase soon reached a maximum with the lard oil, with the new oil the friction continually increased, until finally the journals were smoking, and all the conditions of a genuine hot box realized. The experiment was then extended by causing artificial abrasion with emery, with the same result.

It was then evident that the differences in lubricating value only existed when some accident caused abrasion and generated heat sufficient to vaporize one oil under circumstances which did not vaporize the lard oil. By creating in this manner excessive friction, and persisting in the running of a journal for several hours while miscellaneous abrasion was taking place, so as to score both journal and brasses, and using water to prevent the temperature of the bearings becoming greater than a black heat, that is, preventing their becoming red-hot, I produced a journal which was a fair reproduction of the mutilated crank-pins just described. It was then clear that the brass could tear metal from a journal along lines in any direction, just as a dull tool will tear metal from a cylinder in a lathe. If there are lines of weakness in metal such as may be due to mixed degrees of welding in a crank-pin built up of scrap, these lines will probably aggravate the mutilation. But mutilation is always possible with any two metals as hard as iron on the one hand, and brass or hard white metal on the other. Here is, I believe, a clue to the true solution of the problem, namely, that the only practical differences of lubricating value of oils is in their respective abilities to resist the action of sudden heating due to abrasion of the rubbing surfaces. It is only when the occasional overheating occurs that we hear anything about differences in lubricating value. Such abrasion results either from the gradual and inevitable variations of smoothness due to metallic wear or to accidental temporary interruption in the rate of supply of oil to a bearing. Interruption of the uniformity of the intervening film of lubricant between the rubbing surfaces is a certain and probably the far more frequent direct cause of the abrasion, but in the long run there will be cases of this action when apparently the utmost pains in feeding have prevailed, and the cause of heating must be attributed to the gradual changes of the surfaces, too slight, perhaps, to be discerned by the unaided eye, but which cause a temporary deficiency of oil supply at some point of the bearings. Either directly or indirectly, therefore, the uniformity with which the lubricant insinuates itself between every part of the bearing surfaces determines the success of the lubrication.

With restricted or minimum rates of feeding, the capillary property of lubricants between two metallic surfaces probably controls the uniformity of the conditions of the oil film. Hence nearly every variation of ingredient of compounded lubricants may be accompanied with a difference of ability to cause the lubricant to supply itself to a bearing.

There is as yet, however, no evidence, capable of proving that the broad range of viscosity available in the lubricating products of petroleum cannot afford a lubricant possessing any degree of capillary property to be found among the compounded oils. When the rate of feeding is comparatively superabundant the rate of *escape* of the oil from the bearing may control the rate of supply. Consider once more the case of the car journal. The newly applied brass bears only in spots, as explained above. The coefficient of friction is then about seven per cent., but rapid wear creates a greater area of contact and a highly perfect condition of smoothness, so that in two and one half hours the friction may be one-fourth per cent. with any oil, and then the temperature of the brass settles to less than 100 degrees.

But on the other hand, instead of polishing itself, the bearings may abraid at a spot, and then the heating will become excessive, and no oil will control it.

Thirty minutes of running will then make the shaft actually red hot. There is always so much uncertainty about the brass wearing to the smoother and safe condition that the invention of a lead-lined brass was a great boon to railroad lubrication.

The soft lead lining cannot cut the journal, and it is impossible for the area of bearing to be less than several square inches for more than an instant of time at the start, as the lead flows under the pressure like a very thick grease. A journal excessively scored with a brass can be immediately reloaded, if a lead-lined brass is applied, and no overheating occur.

But suppose that the bare brass has been successfully worn to the polished area, which affords the very low coefficient of friction of one fourth per cent. variation in its friction; then suddenly the friction may double itself with no change of any condition that can be discerned. If the rubbing surfaces are closely examined, some very slight change of smoothness is apparent; but it would attract no attention if the friction index had not suggested a disturbance of perfect conditions. Gradual infinitesimal wear has caused the variation of friction. If the load is considerably increased after running some time at a fixed pressure with a minimum friction, the friction may suddenly increase ten times, and many hours of nursing be required to nurse the bearings back to the minimum friction condition, yet the coefficient of friction will only then be about 2½ per cent., which will not produce a temperature sufficiently high to attract attention or cause complaint. If a grain of dust or grit be thrown between the surfaces the friction will also suddenly increase. Such variations are constantly going on, with apparently a steady and sufficient supply of oil.

It is easily conceived, therefore, how, in the midst of the many irregularities of car service, such accidental variations of friction may occur as are necessary to bear out our hypothesis regarding the accidental generation of intense heat at portions of the bearing surfaces and consequent disturbance of the uniform oil supply to every part of the rubbing surfaces, which finally results in excessive heating and mutilation of the journal. Undoubtedly the most important element in lubrication is that oil shall reach every part of the surface. Anything that induces oil to neglect to interpose itself between a spot of the rubbing surfaces is a possible cause of overheating. Anything that improves the distribution of oil reduces friction. In this fact lies the explanation of the curious paradox that sand or emery, or grinding material of any sort applied to an excessively overheated bearing improves it. To understand how this can be, consider the action of a journal run without oil under heavy pressure. It is cut badly, and the brass is clotted upon it. It runs with a coefficient of friction of, say, forty per cent., which would quickly heat a bearing to redness, if no remedy was applied. We mix emery with oil to form a thick paste, and apply it to the bearings at 1,000 pounds pressure per square inch. Instantly the surfaces are scored with grooves or rings, *but the coefficient of friction reduces itself to, say, eighteen per cent.* The emery has cut grooves for itself in which the particles roll with very little friction, for upon cleaning off the emery and running with clean oil, the friction is no less. The grooves *fit* each other without excessive abrasion.

The friction is still far above the four or five per cent. which maintains the journals cool. There is, therefore, no conflict of the facts with the well-known influence of grit in increasing the friction of a bearing in practically perfect condition. The conditions are, however, a great improvement over the dry brass-coated journal, *because the grooves cause a perfect distribution of the oil.* Cooling compounds, or flour of sulphur, act on the same principle, but must be applied before the abrasion becomes so excessive, as they are comparatively feeble in their grinding properties. As long as the grooves *fit each other*, the friction will be no greater, and may gradually become less than the eighteen per cent.

But if the brasses are forced laterally out of the grooves in the journal, or, if a smooth journal is run with the smooth brasses, the corrugations in the surfaces are crushed, and the journal tends towards the condition of maximum friction once more as the brass begins to attach itself to the journal, and uniformity of supply of lubricant is destroyed. If the brasses are lined with some of the soft anti-friction metals, however, the crushing down of grooves by a smooth journal does not cause excessive friction. Herein lies the true advantage of these metals. They give us no less friction than bare brass when both metals are equally smooth.

Also when abraided by emery or other means, or when run without a lubricant, the friction is equal to that of brass, and any white metal will eventually melt if the brasses surround journal. But they allow themselves to be more rapidly worn to a smooth or safe condition than does brass, and better resist being disturbed from this condition. So that the *chances* of heating are less with soft anti-friction metal than with bare brass or hard white metal. There are circumstances, however, when overheating will take place even with a lead-lined car brass. An instance of this occurred on a certain railroad. A considerable number of lead-lined brasses overheated. It was found that the lead had worn through to the brass at the middle, and not near the ends, owing to a variation in the structure of the brass.

At the middle of the latter chemical analysis showed absence of phosphorous. Elsewhere the material was phosphor bronze. The difference in the rigidity of the two metals induced such an unequal distribution of pressure, that the uniformity of the oil film was unduly disturbed, and hence abrasion occurred at the middle, ending in excessive heating, and the final withdrawal from service of the particular lot of brasses in which the irregularity of structure occurred.

Enough has been said, I think, to show that the differences of lubricating value of lubricants, upon which the opinions of practice are founded, are not revealed by their behavior between rubbing surfaces artificially prepared and supplied with oil, whatever the pressure and speed of our testing machines; but that to develop these differences we should provide bearings and conditions of feeding oil, which shall provoke a range of irregular action by abrasion and heating, and then study the behavior of the lubricants carefully.

It is hardly necessary to state that, under these circumstances, to determine the relative value of two lubricants in as many hours is an impossibility.

* This is the conclusion of this address; the preceding portions have been published in our issues of Oct. 23 and 30.

Sibley College of Mechanical and Electrical Engineering.

Mr. S. G. Pollard writes us as follows: The following is the list of non-resident lecturers elected for the ensuing year: Prof. Mendenhall, Supt. of the United States Coast Survey; Prof. S. P. Langley, Supt. of the Smithsonian Institution; Alexander Graham Bell; W. A. Anthony; Captain R. W. Hunt, Past President of the American Institute of Mining Engineers; Mr. J. M. Allen; Mr. Holloway, Past President of the American Society of Mechanical Engineers; Eckley B. Coxe, who held the same office in the Mining Engineers' Association; Charles E. Emery; Dr. C. B. Dudley, of the Pennsylvania R. R. Mechanical and Chemical Laboratories; Prof. Elihu Thompson; F. J. Sprague; Mr. E. D. Leavitt, Past President of the Mechanical Engineers; and Mr. Rothwell, of the Civil and Mining Engineers.

At the recent meeting of the University Trustees, $50,000 was appropriated for new machinery and apparatus for Sibley College.

The Seniors in Mechanical Engineering are soon to make a running test of a locomotive on the L. V. R. R., under the charge of Prof. Carpenter.

Prof. Thurston has been elected "Member Correspondent" of the "Superic. School l'Industrie Nationale" at Paris, in recognition of his services to science in presenting the English-speaking engineers with the works of the elder Sadi Carnot, the pioneer of the science of thermodynamics.

Meeting of the American Society of Mechanical Engineers.

Secretary Hutton has given notice that the next meeting of this society will be held in Richmond, Va., Nov. 11 to 14. The first session will be at 4 P. M., Nov. 11, in the hall of the Exchange Hotel. The list of professional papers for the meeting is as follows: Light Cable Road Construction, Frank Van Vleck; Authorities on the Steam Jacket, Facts and Current Opinions, R. H. Thurston; Chimney Draught, Facts and Theories; A Novel Form of Flexible Tubing, T. R. Almond; Heat Transmission through Cast-iron Plates Pickled in Nitric Acid, R. C. Carpenter; Some Properties of Ammonia, De Volson Wood; Mechanical and Physical Properties of Sulphur Dioxide ($S O_2$), De Volson Wood; Theoretical Investigation of Efficiency of Vapor Engines, De Volson Wood; Experimental Determination of the

Latent Heat of Ammonia, D. S. Jacobus; Automatic Regulation of Injection Water to Vapor Condensers, Jas. McBride; Hydraulic Hoisting Plant for the Pier of Brooklyn Sugar Refining Co., Louis G. Engel; Hydraulic Traveling Cranes, Erwin Graves; The Single-acting Compound Engine, W. A. Bole; Rope Driving, C. W. Hunt; Accident-preventing Devices for Machines, Jno. H. Cooper; New Process for Generating and Cutting the Teeth of Spur Wheels, Ambrose Swasey; An Interesting Experiment with a Lubricant, Geo. W. Bissell; Performance of a 75-ton Refrigerating Machine of Ammonia Compression Type, James E. Denton; Some Novel Experiments with a Lubricant, James E. Denton.

Following is the list of "topical questions."

83. Is there any reason why corrosion should be more active in one place rather than another, inside a steam drum properly piped to connect several boilers in a battery?

84. What limits are there to the speeds of a hot air or caloric engine? What is the least and the greatest number of revolutions per minute about which you know in such engines?

85. How many times per minute can a dash-pot apparatus be lifted, such as is used with Corliss' valve gear.

86. Which is better economy in a foundry cupola—to melt rapidly, producing a relatively cool iron, or to melt more slowly, producing hotter iron?

87. Have you had any experience in outdoor work at night, in wind and storm, with portable apparatus for light in large quantities, other than electric light?

88. What is the best design for line shafting transmitting over fifty horse-power, permitting them to be stopped and started on any floor, without interfering with the motor, or other shafting?

89. What is the best method of correcting for the superheating of steam in figuring a boiler test?

90. In arranging chimney stacks for a battery of boilers, is it best to use one for each pair, or a larger chimney for the entire battery?

91. Will there be any difference in the size of the chimneys required when the boilers are the ordinary tubular type, or of some of the water-tube forms?

92. What is the best form of cylinder lubricator for engines carrying 140 lbs. of steam pressure or over?

93. What are the maximum safe speeds for hoisting and reversing in an overhead traveling crane, in a machine shop?

Excursions, entertainments and receptions will fill out the time, no doubt profitably and pleasantly. Headquarters will be at Exchange Hotel.

An English Opinion of American Work.

The following letter is of interest, as showing the esteem in which American mechanical work is held in England:

26 MARCHMONT ST., RUSSELL SQUARE,
London, England,
October 14, 1890.

DEAR SIR: Allow me to say that I get more mechanical notions for my business of electrical engineer out of your paper than all the English ones put together. I wish you could devote more space to small work.

Regarding the durability of your [American] work, you may like to hear that I have still going, one of Chauncey Jerome's 30-hour striking clocks; bought in 1856 or 1857. Its utmost error is 2 minutes. It is cleaned about every five years, never regulated, and has had only two repairs; new pallet and new pendulum spring. Few English clocks could show an equal record for 34 years.

Again, I have a boxwood foot rule, folding to 3 inches, by E. A. Stearns & Co., Brattleboro, Vermont; my father and I have had it in daily use for nearly 50 years. It has shrunk about $\frac{1}{50}$ inch, but that may perhaps be due to wear. The outside divisions are scarcely legible, but the joints are as stiff and perfect as when new. Everybody admires its wonderful strength.

C. PURCELL TAYLOR, D. Sc.

LETTERS FROM PRACTICAL MEN.

Western River Steamboat Engineering Practice.

Editor American Machinist:

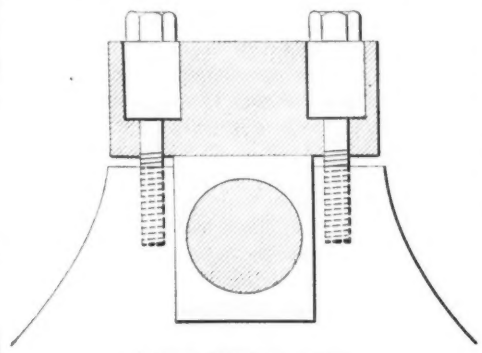
Many of your readers, no doubt, have heard of the primitive-looking steamboat engines and boilers on Western river boats, and perhaps heard them ridiculed by those who do not know the necessities of the situation. A friend recently gave me a report of a test made in 1871, by Mr. James McBride, of the side-wheel packet Arlington, that ran between Cincinnati and Pittsburgh, which shows what such steam machinery does in actual service. It is not so primitive in results as might be supposed.

The Arlington had five cylindrical boilers, 38" diameter and 24 feet long, each containing two return flues, 13½" diameter. The total amount of heating surface was 1,214 square feet, government rule. The grate surface was 66 square feet, placed 16" below bottom of boilers. The boilers are fed by pumps, which put exhaust heated water in at 180°. There were two engines, each 22½" diameter of cylinder, and 7 feet stroke, which ran at 16 to 18 revolutions per minute. Each cylinder had 4 poppet valves—two inlet 5½" and two outlet 6½" diameter. The clearance at each end was 5.8 per cent. of piston displacement.

From indicator diagrams taken, it was found the initial pressure, up to point of cut-off, averaged but 3 pounds below boiler pressure. The point of cut-off, shown by the cards, was about .4 stroke. The average mean steam pressure, shown by the cards, was 97.6 pounds, and average back pressure 2½ pounds, leaving a mean pressure of 95.1 pounds, which, with a piston velocity of 252 feet per minute, shows 267 horse-power for each engine, making in all 534 horse-power.

It will be seen from the foregoing figures that a horse-power is developed for every 2.27 square feet of heating surface, which certainly is about as good results as are likely to be found in boiler practice elsewhere. This was not the result of a short trial, but what the boilers would do continuously during a two days' trip.

The amount of water evaporated per hour per horse-power was about 36 pounds. No exact measurement of coal used was made, but an estimate was made from knowledge of the total amount consumed during a round trip, which placed it at about 4½ pounds per horse-power per hour, which would be an evaporation of 8 pounds of water per pound of coal. BELL CRANK.



LATHE CONSTRUCTION.

Lathe Construction.

Editor American Machinist:

After an experience of over forty years in machine shop practice, I agree with Prof. Sweet that it is a handy thing to have at least one lathe in the shop with a swivel head-stock.

My experience has shown that the cap over the main journal, as usually made, is too light, and the bolts too small and too much spread. I think it would be well to tell the designer to make the cap extra heavy—thicker than it is wide—and then, before the drawing goes to the pattern maker, just alter the figure, and make the thickness double what the designer had it. He might not like it, but the man who uses the lathe on a tough boring job would.

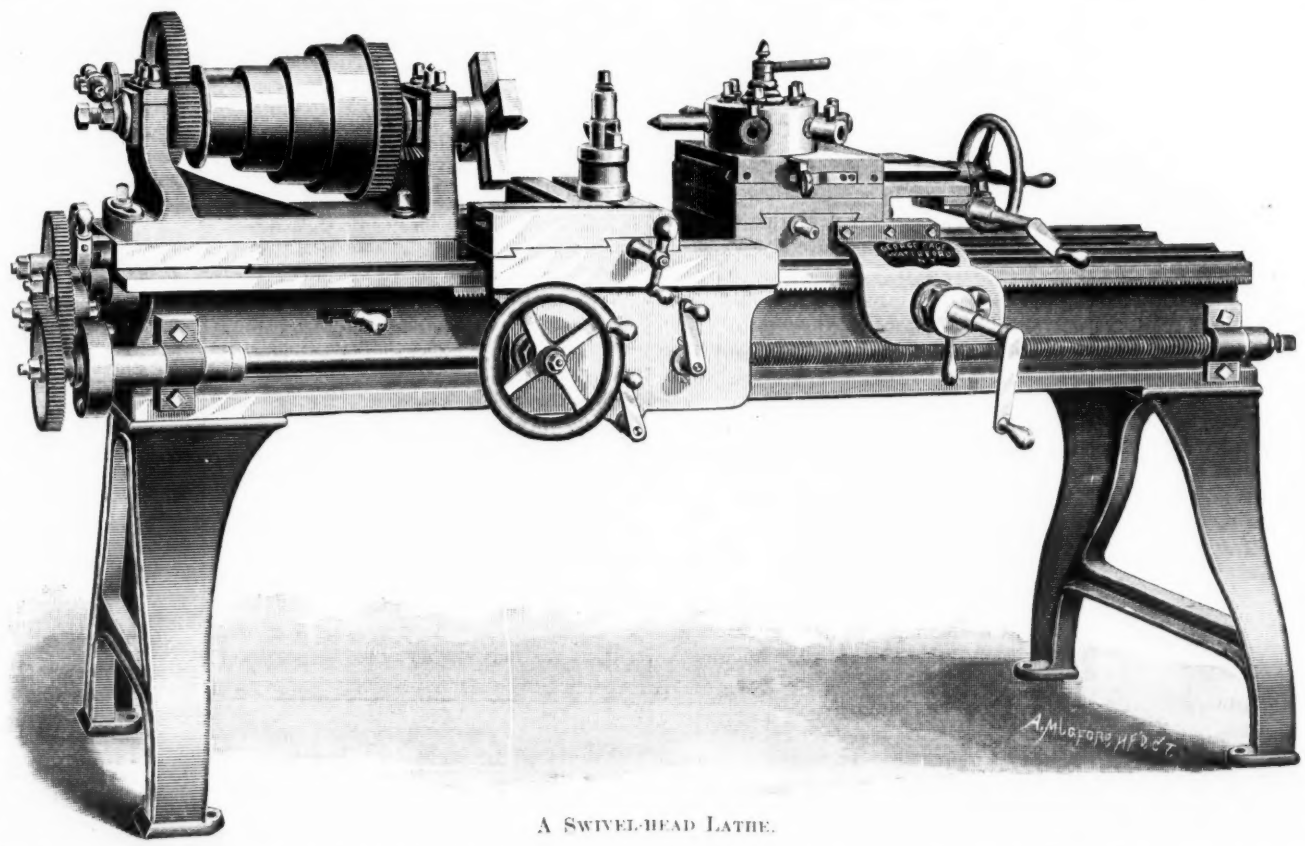
The bolts should be extra large, and, to get rid of the major portion of the elasticity of both cap and bolts, the bolts should be placed as near the box as practicable, the holes in the cap counterbored, as shown in the sketch, and the shanks of the bolts enlarged to shoulder as shown. BENJ. F. WILSON.

The president of the United States recently spoke to those who had gathered to hear him, at St. Joseph, Mo., at 6:30 A. M. He assumed that his hearers had come to welcome him before breakfast, laying considerable stress upon this. Perhaps the president has not yet learned that the great majority of his constituents are obliged, by force of circumstances, to breakfast before that hour.

A Swivel-head Lathe.

As our readers know, there has been for some little time past considerable discussion among our friends, through our columns, regarding the comparative merits of the different methods of fastening the head-stocks of lathes to the beds, some maintaining that the molder should fasten them on, while others think that they should be bolted or arranged to swivel. In our issue of October 16, Mr. Geo. W. Clarke referred to his experience with the Gage lathe having a swivel head, and as we are convinced that many of our readers are unfamiliar with this lathe, we give herewith an illustration of it as it appears fitted with turret head and slide, instead of the ordinary foot-stock.

As will be seen, there is a plate or base under the head-stock, which is bolted to the bed in the ordinary manner, and upon this base the head rests and can be swiveled to any desired angle within the limits usually required for lathe work. Just outside the large gear on the spindle is a small bevel gear, which drives a small gear on a vertical shaft, which passes down through the trunnion upon which the head swivels, and by means of other bevel gears drives a shaft which passes along under the head horizontally to the end of the bed, where it drives the train of gears by which the feed-screw is driven. This shaft is not driven direct, however, but by means of a double-ended clutch, which, when thrown from one side to the other by the small lever shown, reverses the motion of the feed, an intermediate position stopping it. As this clutch is so arranged that when thrown in it always engages at the same point, and as the shaft revolves at the same speed as the spindle, threads are thus cut without reversing the motion of the lathe, and without stopping it. The style shown is intended mainly for brass work, though of course it will be found suitable for any work for which turret-head lathes are usually employed. It is 18-inch swing with 7-foot bed, and has a hammered steel spindle with bronze boxes. The turret has six holes, which are bushed with steel, has a set-over and swivel motion, and is operated by screw or rack and pinion motion Various styles of the lathes are built, embodying the same principles, some having the usual feed rod and worm in addition to the screw, and a splined shaft which passes along the front of the machine by which the feed can be reversed at any point along the bed, as would of course be necessary in the case of an engine lathe of any considerable length. The lathes are built by the Gage Machine Works, Waterford, N. Y.



A SWIVEL-HEAD LATHE.

Considerable doubt has been expressed in naval circles as to the possibility of the eight-inch guns of the Atlanta and Boston being worked in a heavy sea. Now it would appear, if we accept the authority, that the eight-inch guns can be worked when it would be unsafe to attempt to work the six-inch guns. Both these vessels are said to roll rather viciously, which statement does not, probably, amount to anything worth speaking about. The fact is that our fighting ships can never be tried only by the test of actual fighting, and every one trusts our navy will not before it is brought to that test.

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NEW YORK, NOVEMBER 6, 1890.

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Tin Plate Talk.

A great deal of loose talk has been going the rounds of the daily and commercial press, during the past few weeks, with reference to establishing the manufacture of tin plates in this country, which is incorrect, and only befogs the situation.

That the recent legislation upon this subject will aid the people of this country to gain a nearer base of supplies for this important product than one located in a foreign country three thousand miles away, is the sincere wish of many. That the country may get out of the new law all the benefit there can possibly be in it, should be the wish of all, including those who were its candid opponents. But it does not advance any good object to have leading daily papers gravely announcing to their readers that at the very moment this legislation was being completed, a Pittsburgh concern was "actually turning out tin plates," in expectation of the protection to be afforded by the new law. Nor will it, as we trust, accomplish any more serious result than the temporary bewilderment of uninformed readers, to have other leading journals publishing glowing accounts of the establishment somewhere each day of two or three new tin plate plants, apparently for the mere newspaper purpose of contradicting the story next day. Other journals, actuated by still different motives, seem to lose no opportunity of collecting such items, obviously for the purpose of proving to their readers, beyond a peradventure, that the manufacture of tin plates never can and never will be built up in this country.

That it will not be built up by a wholesale hegira of British manufacturers to the United States, is already quite evident, but we think the fact is one not wholly to be deplored. We have on unquestioned authority the significant fact that a leading British manufacturer of tin plates, and a party of friends visiting this country as members of the British Iron and Steel Institute, have reached the conclusion that it will not be profitable to them to carry out a project which they had been previously considering. That project was the investment of one million dollars and the establishment of a large tin plate plant in this country, if, after personal examination, they found the conditions favorable. They talked with British workmen, now residing in this country, whom they had known in their own districts, and also inspected the methods and conditions prevalent in American rolling-mills. They found the American workmen employed therein getting very much higher wages than was paid in England for similar work. Their conclusions were further aided by the fact that the new tin plate duty, after allowing for the prospective advantage to be afforded the producers of pig-tin, will afford the American manufacturers of tin plates an additional protection of only about one cent a pound over that which has, during so many years, proved wholly insufficient for the purpose of starting the industry here. Of course, too, they reasoned that their brother manufacturers at home would be unwilling to give up this great market without a severe struggle, and that American prices of tin plates had in past years frequently been much higher than the new duty can possibly necessitate, without serious complaint on the part of users, or inducing American manufacturers to undertake the business of making the plates here. Naturally, therefore, it is not surprising such representative British manufacturers would be more apt to stand by their guns than to locate new works here, unless they could do so with a certainty of reaping large profits.

But, in our opinion, the worst thing this can mean is simply that the American tin plate industry will be American, and we do not think the industry will, in the long run, be any the worse off, because, when established, it will be upon the basis of close margins and moderate chances of profit. Whatever imaginings may be indulged in by any one, tin plate works are not going to grow up over night, like Jonah's gourd, for the very sufficient reason that machinery designed for other purposes cannot be made over at will to suit the competitive conditions which must prevail in the tin plate market here as elsewhere. New machinery and appliances throughout will have to be designed and constructed, and existing methods must be studied and improved upon before the American manufacturer, with or without help from the new law, can expect to cope successfully with his foreign competitor.

That the inventive genius, mechanical skill and business energy of American mechanics and manufacturers, which have solved greater problems in the past, will solve this one, we have no kind of doubt. But it will not be done in a week or a month, and no discouragement should be felt by any one because of that circumstance.

Liability Insurance.

Almost three years ago, when the business of insuring employers against liability of loss arising from accidents to workmen was beginning to be pushed in this country, we called attention to some of the features of the business, and took the ground substantially that, inasmuch as the courts would not award damages to an employe injured by machinery or other apparatus, unless it were proven that there had been neglect of the proper precautions for the prevention of accidents, for which neglect the employer was responsible, the taking of such insurance was, in a certain sense, an acknowledgment that proper precautions were not taken, and that if every reasonable precaution were taken by an employer, there would be no liability upon his part, and, therefore, no need for the insurance.

Of late, however, we have begun to see in passenger elevators, in this and other cities, notices to the effect that the elevator is regularly and periodically inspected by its builders, whose names are given, for the accident liability insurance company.

We understand that the method now pursued in such matters is to take the kind of elevator and all its surroundings into consideration when investigating it, with a view to writing a policy. Then, if it is insured, a reliable builder of elevators, and, where practicable, the builder of that particular elevator, is employed to make a thorough inspection, and, if anything is found wanting in order to make it safe, to supply it.

Upon the receipt of the builder's detailed report, showing it to be all right, the policy is issued, and the elevator is then periodically inspected, and, if found to be at all dangerous at any time, the owner must at once put it in good condition, on penalty of having the policy canceled. We feel constrained to say that, to the extent that the business is carried on in this way, it will prove in practice to be a good thing for all concerned, but especially for those who, as passengers or employes, have occasion to trust their lives to elevators.

Without this systematic inspection and enforcement of provision against accidents, it has been demonstrated that such matters will, in the majority of cases, be neglected. The same method applied to a machine shop or factory where machinery is used could hardly fail to prevent many accidents, and the prevention of accidents is, of course, far better than any amount of damage payments as compensation for them after they have occurred.

Such a company can, and naturally will, when doing business on this principle, make a much more thorough study of the causes of accidents, and the best means of preventing them, than would usually be practicable for an employer, and if, having made this study, the companies will require a strict compliance with the regulations shown by experience to be necessary, their influence will be for good. The business can be so managed that a workman knowing that his employer carries insurance against loss by damage suits in case of accidents, will by that fact have the best possible assurance that the danger of accidents to him has been reduced to the lowest possible limit, so far as others can protect him from them, and it is to be hoped that this ideal will be attained.

If it were possible for a company to be organized strong enough to insure railroad companies against loss by accidents, and which, as a feature of the business, should require that every possible or practical provision should be made for their prevention, and see to it that there was no relaxation of vigilance, and no safety appliance neglected, few can doubt but that such a company would effect some needed reforms, and would accomplish great good. Ships are insured by companies which conduct business in such a way, and the manufacturers' mutual companies protect their members against fire by the application of the same principles, and the principle which is so entirely successful with them might be applied in other directions, it seems to us, with good chances of success. Mere gambling upon the chances of accidents, and then fighting to avoid the just penalties attending those which occur, we can see no good in, but when those who may lose by their occurrence take every possible means to prevent them happening, it is so far a good thing.

According to press accounts, an accident occurred at Lynn, Mass., recently, which is in some respects without a parallel. It seems that a large Corliss engine was used for driving dynamos for electric lighting. By some means the wires leading from the dynamos were suddenly burned out, and the connection to the dynamos being thus broken, and the engine relieved of its load, it raced until the fly-wheel gave way, wrecking the engine and the engine-room. It is difficult to understand how such an accident could have occurred with a Corliss engine, and the only theory upon which we can account for it is that the wheel must have been running so nearly its safe limit of speed that the slight increase which could take place under such circumstances was sufficient to cause the rupture. We do not think there are any Corliss engines built that will race sufficiently even when all the load is suddenly thrown off, to cause a wreck, unless either there is something wrong with the cut-off mechanism, which should be looked to by the engineer, or, for some reason, the ordinary working speed of the engine is dangerously near the safe limit. At any rate, it is safe to say that the circumstances under which such an accident would be really unavoidable are very rare.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(424) W. F., ——, writes: Please inform us if 4 boilers 50 inches diameter, 16 feet long, with two 16-inch flues, will furnish steam enough for an engine whose cylinder is 24 inches diameter, 6 feet stroke, number of revolutions 35 per minute, cut-off at ¾ of the stroke, boiler pressure, 85 pounds. *A.*—The boiler capacity is not near large enough; it is only about ⅓ of what it should be.

(425) F. W. S., Fort Myer, Florida, writes: Kindly inform me how the inspectors of marine boilers find the ductility of boiler plates as entered on the inspection certificates, and how I can find the ductility of any metal in similar values for comparison. *A.*—The ductility of iron or other metals is found by actual tests made in a machine constructed for the purpose; machines of this kind are illustrated and described in *Appleton's Cyclopædia of Applied Mechanics*, and in other books treating on engineering. 2. How can I tell whether a boiler plate is cyrstallized or not when it is in the boiler? *A.*—We do not know of any other way than to cut a piece out of the plate for examination. But generally no trouble need be apprehended from crystallization of boiler plates.

(426) J. B., Laramie, Wyo., writes: Please give the proper method for laying out a rocker for a locomotive, and state the reason for throwing the lower arm out of line; give

an example if necessary. *A.*—In designing a rocker the first tep is to locate the center *o* (Fig. 1), of the rocker shaft; the position of this center will depend on the general arrangement of the mechanism in the vicinity of the rocker, and nothing but good judgment is required for locating it. When the center *o* has been found the length of the upper rocker arm is also known, it is equal to the distance from the center *o* to the center line of valve rod; some builders make it slightly longer, so that the center line of valve rod will pass midway between the highest point in the arc and the extremities of the arc described by the center of the upper rocker pin. The length of the lower rocker arm is made equal to the length of the upper one when it is possible to do so; sometimes the lower arm will have to be made shorter, so as to give a sufficient amount of clearance between the bottom of the link and the rails of the road; on the other hand there are cases in which the lower rocker arm must be lengthened to allow the link hangers to clear to bottom of the boiler; and again it is sometimes desirable to use eccentrics whose throw is greater than it should be for the travel of the valve; in cases of this kind the lower rocker arm will also have to be made longer than the upper one, so as to transmit to the valve the proper travel. The offset of the lower rocker arm is found as follows: From *o* as a center, and with a radius equal to the length of the arm, describe an arc *u*, through the center *C* of the axle draw a line *C M* tangent to the arc *u*, and through *o* draw *o k* perpendicular to *C M*; also through *o* draw the line *o n* perpendicular to the center line of the valve rod; the lines *n o* and *o k* are the lines to which center lines of the arms must be set. From the foregoing it will be seen that since the rocker is nothing else but a convenient piece of mechanism to connect the link to the valve rod, its position and length of arms must be made to suit the motions of the link and valve, and no other rules can be given. For the thickness and width of arms, also the length and diameter of the shaft, see eighteenth paper, Modern Locomotive Construction, in our issue of February 13, 1886.

(427) H. S., ———, Florida, writes: In answer to Question 392, in your issue of Oct. 2, relating to the safety valve, you have $50 \times 12.566 \times 4'' = 12.5 \times 20'' + T \times 20''$. Should not the term 12.5×20 be 12.5×4; that is to say, should not the weight of the lever be multiplied by the horizontal distance from center of valve to fulcrum, instead of from center of valve to the place of ball? I have a formula which states that the weight of lever should be multiplied by the distance from center of valve to fulcrum, and I want to find out if I understand it right. *A.*—The term 12.5×20 is correct, but the next term $T \times 20$ should have been $T \times 24$, as has been explained in Question 403, in our issue of Oct. 16. The term 12.5×20 gives the moment of the weight of the lever about the fulcrum. In finding this moment we assume the weight, 12.5 pounds, of the lever to be concentrated in a single point; this point is called the center of gravity of the lever, and its position is not affected by the position of the ball. According to the problem given in Question 392, the center of gravity is 20 inches from the fulcrum, and this distance is not changed by placing the ball on this point or at any distance away from it; it must be distinctly understood that the position of the ball has nothing to do with position of the center of gravity of the lever. Here then we may assume that there is a force of 12.5 pounds acting in a vertical direction, and the distance from the fulcrum to the direction in which this force acts is 20 inches. Hence the moment of this force is $12\ 5 \times 20 = 250$. It will be noticed that according to the conditions of the problem, the weight of the disk and valve spindle was not to be considered; if, on the other hand, these weights are taken into account, we should find the moment of these weights by multiplying the sum of these weights by their distance from the fulcrum, 4 inches; the product will be the moment of these weights about the fulcrum. It is probably this moment to which your formula refers, instead of the moment of the lever. All safety valve problems are simply interesting examples of the application of the principle of moments, and if these principles are understood, and which we have endeavored to explain thoroughly in our answer to Question 392, engineers should not have any difficulty in solving any safety valve problem.

(428) J. W. G., Philadelphia, Pa., asks: What is the indicated horse-power of a triple expansion engine with cylinders 6, 10, 17 inches diameter and 8 inches stroke; steam pressure 70 pounds, number of revolutions 130 per minute? *A.*—A condensing engine of this class and size will develop about 33 indicated horse-power. For so low a steam pressure as 70 pounds we prefer to use a compound, in place of a triple expansion engine. 2. How many cubic feet of steam would be used in cutting off at ¼ stroke? *A.*—25.48 cubic feet per minute. 3. Please give rule for finding the horse-power of an engine. *A.*—In answer to Question 25, in our issue of January 26, current volume, you will find the rule for computing the horse-power of a simple engine. For compound engines of any sort, it is customary to calculate the horse-power, as if the total expansion occurred in the cylinder or cylinders that exhaust into the condenser; and it is assumed that the expansion curve is a rectangular hyperbola. Or, in other words, we may say that the power of a compound engine depends on the size of the large cylinder, and is the same as that which would be obtained from a single cylinder of the same content, by expanding to the same extent from a like initial

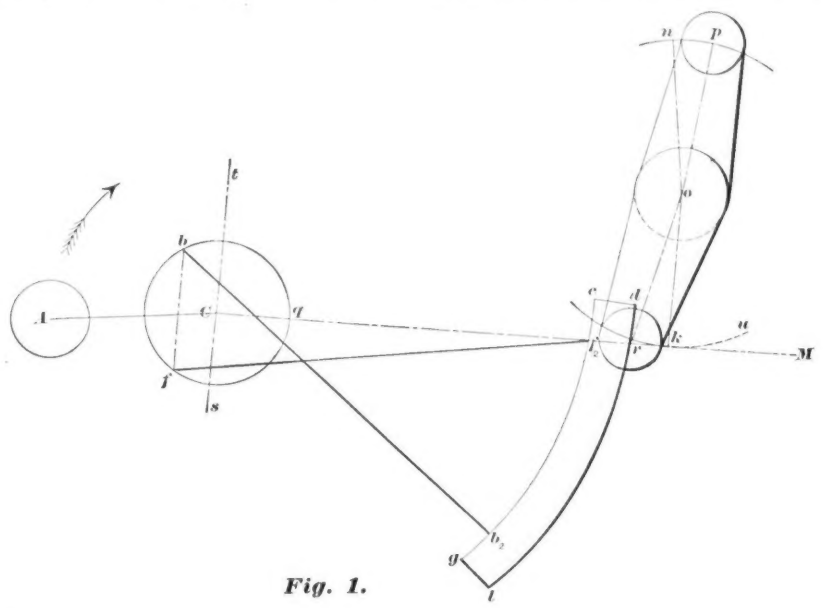

Fig. 1.

steam pressure. The rule for computing the indicated horse-power of a simple engine is

$$I.\ H.\ P. = \frac{P\ L\ A\ N}{33{,}000}.$$

In which *P* denotes the mean effective pressure in pounds per square inch of piston; *L* the length of stroke in feet; *A* the area of the piston in square inches; and *N* the number of strokes made by the piston in one minute. The mean effective pressure is found by the rule given in answer to Question 412, in our last issue. To illustrate the application of these rules, we will compute the indicated horse-power of the triple expansion engine here given, and we shall assume that the total number of expansion is 8, and the back pressure 5 pounds. The steam pressure is given at 70 pounds, hence the absolute steam pressure will be $70 + 14.7 = 84.7$ pounds. The hyperbolic logarithm of 8, is 2.079, adding 1 we have $1 + 2.079 = 3.079$; dividing by the number of expansions we have $\frac{3.079}{8} = .384$; multiplying this by the absolute steam pressure we obtain $.384 \times 84.7 = 32.52$ pounds mean pressure; subtracting the back pressure we have $32.52 - 5 = 27.52$ mean effective pressure. This is now the value of *P* in the given formula, and substituting for the symbols their values we have

$$I.\ H.\ P. = \frac{27.52 \times .666 \times 226.98 \times 260}{33{,}000}$$

= 33 indicated horse-power, nearly. Here we have not taken the clearance, or the effect of a receiver into account, consequently the result should be looked upon as a close approximate estimate only.

(429) D. W. H., ———, Wis., writes: In the description of the link motion by J. G. A. Meyer is a point that I do not understand. In problem 3, Fig. 5, it says that the center line of motion determines the position of the eccentrics. I should think the crank-pin would determine the position of the eccentrics. *A.*—Let *C* (Fig. 1) be the center of the axle, through this point draw a line *C M*, tangent to arc *u* described by the center of the lower rocker-pin; the line *C M* we may call the center line of motion of the reversing gear. Through the center *C* draw the line *s t* perpendicular to *C M*, and from *C* describe the circle *f b q*, which represents the path of the center of eccentrics; consequently its radius must be equal to the eccentricity of the eccentrics. If now the length of the lower rocker-arm is equal to that of the upper one, then the point *f*, which is the center of the forward eccentric at the beginning of the stroke, must be laid off from the line *s t* at a distance which is equal to the sum of the lap and lead, and the distance from the point *b*, which is the center of the backward eccentric, to the line *s t*, must also be equal to the same distance; in short, the positions of the forward and backward eccentrics are found by drawing a line *b f* parallel to *s t*, with a distance equal to the sum of the lap and lead between them. Here it will be seen that no attention has been paid to the position of the center line *A C* of the crank; if this line coincides with the line of motion *C M*, then it may be said that the eccentrics are set to a line perpendicular to the crank, and indeed this is true in many stationary engines, but it does not follow that this is true for all engines. On the other hand, we can assert that in all engines the eccentrics are set to a line drawn perpendicular to the center line of motion of the valve gear, or, in other words, it is the center line of motion of the valve gear which determines the position of the eccentrics. It may be stated here that in order to make the construction absolutely correct, the center line of motion *C M* should not be drawn tangent to the arc *u*; it should be drawn a little above lowest point in the arc; but for all practical purposes, it is sufficient to draw the center line of motion tangent to the arc; the error in the position of the eccentrics resulting from this method will be inappreciable. 2. I have been working on two horizontal engines, 7x10 inches, connected to one crank-shaft. These engines are used for driving piles, and are obliged to run both ways. On the crank-shaft there is a fly-wheel 4 feet diameter, with a rim 4x4 inches. Is this fly-wheel necessary? Does it not strain the working parts to stop this weight suddenly in reversing the engine? *A.*—The fly-wheel is needed; its object is to prevent objectionable loss of speed while the crank is passing its dead centers, and to give a degree of steadiness with which the engine shall run at a given speed. Of course a fly-wheel will tend to strain other parts of the engine when the speed is suddenly checked; but in this class of engines the fly-wheel is comparatively small, so that in the hands of a careful engineer, the parts of the engine will not be strained to any dangerous degree.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
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Shafting Straighteners. J. H. Wells, Tampa, Fla.

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Pattern and Brand Letters. Heber Wells, 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

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Send for W. A. Morrison's Prac. Eng'r. (the standard book), enclose $1.00, Box 373, Lowell, Mass.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Adjustable Shrinkage Gauges. Pedrick & Ayer, Philadelphia, Pa.

Link Milling and Slotting Machine. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Emery in 10 lb. tins (for machinists' use) a specialty. The Tanite Co., Stroudsburg, Pa.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Oct. 9, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Billings & Spencer Co.'s Packer & Boiler Ratchet, & all kinds of Forged Wrenches. S. A. Smith, 23 S. Canal st., Chicago, Western representative.

"Roper's Hand-Books," for engineers and firemen. Send for descriptive catalogue. Address Edward Meeks, publisher, Philadelphia, Pa.

25″, 32″, 37″, 42″ — "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, Newark, N. J.

Patent Attorney R. G. DuBois, 715 11th street Washington, D. C., procures 1st-class patents for inventors. Send for pamphlet. Guaranteed by Rand, McNally & Co., of Chicago.

Every pattern maker and wood worker should have a Dutton's clipper grinder. No. 5. Send for circular to Montgomery & Co., 105 Fulton street, New York City.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES.

An ice factory will be erected this fall at Uniontown, Ala.

The Whiteman Paper Mills, Dansville, N. Y., are to be rebuilt.

The Southern Cotton Oil Co., Atlanta, Ga., will rebuild its oil refinery.

W. H. Withgott is erecting a new iron and brass foundry at Easton, Md.

There is talk of a $500,000 cotton-mill being erected at Yazoo City, Miss.

A knitting and woolen-mill will probably be erected at Morristown, Tenn.

Lill & Hillsley, of Philadelphia, Pa., will erect a nail factory in Kensington, Ga.

A wood pulp and paper-mill plant, to cost $100,000, is to be set up at Ashland, Wis.

A Cincinnati company, it is said, will establish an aluminum factory in Buena Vista, Va.

The plant of the Newmarket (N. H.) Manufacturing Company is to be greatly increased.

The Mt. Joy Novelty Iron Works, of Mt. Joy, Pa., will, it is stated, remove to Frederick, Minn.

The Tiffany Iron Works, at Tecumseh, Mich., has been incorporated, with a capital of $50,000.

An ice factory will be established at Beeville, Tex., by the San Antonio Brewing Association.

A stock company will, it is stated, be organized to erect a cotton-seed-oil-mill at St. Joseph, La.

It is stated that the Roane Iron Co. will construct a mammoth basic steel plant at Rockwood, Tenn.

Smith & Burdette, of Cincinnati, O., are reported as to establish branch pipe works in Bristol, Tenn.

Work has been commenced on the construction of the Ashland Steel Co.'s steel plant at Ashland, Ky.

The Marble Falls Manufacturing Alliance will erect a cotton bagging factory at Marble Falls, Tex.

The Elizabeth City Crystal Ice Co., lately organized, will erect an ice factory at Elizabeth City, N. C.

It is stated that an electric light plant will be erected, and water-works constructed, at Stanley, Va.

The Moffat Manufacturing Company, of Chester, S. C., is adding an iron foundry to its implement factory.

The Mossy Creek Foundry and Machine Co., Mossy Creek, Tenn., will put in additional machinery.

D. L. Trusselt is organizing a stock company to establish a foundry and machine shop at Carrollton, Ga.

The Beaver Tube Company has been incorporated, at Wheeling, W. Va., with a capital stock of $1,000,000.

The Athens Electric Light and Power Co., Athens, Tenn., has received franchise to erect an electric light plant.

Efforts are being made to organize a stock company to build a foundry and machine shop at Carrollton, Ga.

Edward Rasch has, it is reported, added a foundry and machine shop to his iron railing works at Florence, Ala.

It is stated that work will soon be commenced on the construction of an iron furnace to be built at Pell City, Ala.

The Union Pacific Railroad Company is reported as to erect machine shops at Fort Worth, Texas, to cost $1,000,000.

It has been decided to rebuild the lately burned foundry of the Van Winkle Gin and Machinery Co. at Atlanta, Ga.

The Merchant's Shot Tower Co., of Baltimore, Md., has transferred its property to the American Shot and Lead Co.

It is said that New York and Washington parties are negotiating with a view of establishing iron works in Wiston, N. C.

It is said that New York and Washington parties are negotiating with a view of establishing iron works in Winston, N. C.

The Dennis Duplex Machine Co. have filed articles of incorporation at Des Moines, Ia. The capital stock is placed at $500,000.

A new cotton-mill is projected at Oxford, N. C., to cost $100,000, of which the Oxford Land Company is to subscribe $50,000.

The Springfield Boiler & Mfg. Co., Springfield, Ill., have erected boiler works, and will build a foundry and machine shop.

It is stated that the Rome & Decatur Railroad Company has purchased a site for the erection of machine shops at Decatur, Ala.

The Beaver Tube Co., chartered with a capital of $1,000,000, at Wheeling, W. Va., will soon start work on its plant at Lewisburg.

The East Tennessee, Virginia & Georgia Railroad Co. (office, Knoxville, Tenn.,) will, it is stated, erect machine shops in Brunswick, Ga.

Work has been commenced on the buildings of the South Boston Iron Works, at Middlesboro, Ky. The main building will be 1,200x150 feet.

The Eden Manufacturing Company, of Eden, Pa., has been incorporated, with a capital of $12,000, to manufacture cotton and other textile fabrics.

A company is reported as being organized at Blacksburg, S. C., to erect a factory for the manufacture of the Joseph Black patent cooking stove.

The Beedle & Kelly Co., of Muskegon, Mich., has been chartered, for the purpose of manufacturing implements and machinery; capital stock, $100,000.

The Hygeria Ice Company has been formed at Chicago, Ill., to manufacture ice; capital, $500,000; incorporators, Edwin Corben, Albert Chapelle and others.

S. H. Letcher, O. O. Owens and others, of Richmond, Va., have incorporated the Waddell Railway Signal Company, to manufacture electric railway signals.

The J. N. Sarborough Manufacturing Co., of Americus, Ga., will be organized, with a capital stock of $100,000, to manufacture automatic car brakes.

The Virginia Power, Light and Construction Company contemplates the erection of an electric power plant, to operate a street railway, at Lynchburg, Va.

J. H. Gill, of Raleigh, N. C., will establish in Ivanhoe, Va., an iron foundry, machine shops and stove works. Work has been commenced on the buildings.

The Cavner Railway Power Transmission and Brake Company, of Chicago, Ill., has been incorporated, for the manufacture and sale of railway appliances.

Frank Tyman, E. M. Nettleton, W. A. Rinehardt and others, have secured a site at Covington, Va., and will erect a foundry and machine shop, and a steam tannery.

G. E. Wheeler and J. C. Keifer, Wilmington, Del., contemplate erecting a factory at Piedmont, Ala., for manufacturing a patent covering for steam pipes and boilers.

It is reported that the erection of an open hearth steel plant and a bridge shop is contemplated in the near future by the Muskegon Iron and Steel Co., of Muskegon, Mich.

It is stated that the Rockbridge Co. has contracted with Chicago (Ill.) parties for the removal of a steel car works plant to Glasgow, Va. A site has been selected.

An iron furnace is reported as to be built at Choccalocco, Ala. Birmingham parties have made large purchases of land there, and these are probably the projectors.

The Canton Iron Co. has been incorporated by H. S. Chamberlain, Emell Eastmon, O. G. Hurlbut, and others, of Chattanooga, Tenn., to build iron furnaces at Canton, Ga.

The West Side Iron Company, of Chicago, Ill., has been incorporated, to manufacture iron and other metals. G. G. Willard and Julius Grunewald are two of the incorporators.

The St. Louis (Mo.) Iron and Machine Works are rushing the addition to their works. The new building will be used for the machine shops and the general offices of the company.

The Edward Best Car Axle Box and Lubricator Company, of Ottawa, Can., has been incorporated, with a capital stock of $25,000, and will manufacture car axle boxes and lubricators.

A Philadelphia (Pa.) company is reported as having signed contract for the removal of its steel plant to Fort Payne, Ala. The Fort Payne Coal and Iron Co. can give information.

The L. P. Trottier Axe and Edge Tool Manufacturing Company, of Three Rivers, Que., has been incorporated with a capital stock of $40,000, to manufacture axes, hammers and other tools.

The Supply Manufacturing Co., of Pittsburgh, has been chartered, with a capital of $50,000. The directors are Wm. J. Hammond, Robt. A. Hammond, James H. Hammond and Wm. E. Justin.

The Hattie Ensley and Lady Ensley coke furnaces at Sheffield, Ala., and the mineral lands in Franklin county, owned by Enoch Ensley, have, it is stated, been optioned by Alfred Parrish at $1,500,000.

A company is being organized at McKeesport, Pa., to engage in the manufacture of iron safes. James Evans, W. C. Soles, T. D. Gardner and W. S. Chandon, of that city, are interested in the project.

The Cardiff Rolling-mill Company is the name of a $200,000 stock company organized by M. M. Duncan, H. C. Young, C. P. Moore and others to manufacture sheet-iron and sheet-steel at Cardiff, Tenn.

The Lone Star Iron Co., of Jefferson, Tex., has the building for its car wheel factory completed, and the machinery is being rapidly put in place. The firm expects to commence operations about Nov. 1.

The Embreeville Iron Co., of Embreeville, Tenn., has awarded a contract to the Pittsburgh Iron and Steel Engineer Co., of Pittsburgh, Pa., for the erection of an iron furnace, and work is to begin shortly.

Westinghouse, Church, Kerr & Co., Chicago, Ill., have purchased the old Cragin plant in the northwestern part of the city, will refit the factories, and employ about 100 men in the manufacture of engines.

It is stated that a water-works system and an iron furnace will be constructed, and a sash, door and blind factory erected at Bluffton, Ala. The Bluffton Land, Ore and Furnace Co. can give information.

The National Wheel Company was formed at Jackson, Mich., October 13, with $50,000 capital stock, $35,000 being paid in, to manufacture car wheels. The company will at once build a shop 60x200 feet.

A company, to be known as the Emerson Car Co., has been incorporated at Charleston, S. C., for the purpose of manufacturing A. S. Emerson's ventilating apparatus for railway cars. The capital stock is placed at $300,000.

A $300,000 stock company has been organized, with J. N. Gamble, of Cincinnati, Ohio, president, W. C. De Armond, vice-president, and Archer Brown, secretary, to build an iron foundry and pipe works at Radford, Va.

Roth & Engelhart, of St. Johnsville, N. Y., have broken ground for an addition of 30x100 feet to their piano action factory. They now employ 75 hands, and when their new building is completed they will double their force.

The American Steel Post and Pole Company has been formed at Chicago, Ill., to manufacture and sell steel and metal poles of all kinds; capital, $100,000; incorporators, Thomas J. Thorp, Thomas Bennett, William H. Herrick.

The Ryan-McDonald Manufacturing Co., of Waterloo, N. Y., will remove its machine works to Curtis Bay, near Baltimore, Md., and incorporate a $100,000 stock company to operate them. A building 70x350 feet is to be erected.

The Lookout Rolling-mill Co., at Harriman, Tenn., has the foundation of the new works under way. The present capacity of the mill is 45 tons a day, but with the proposed additions, the average will be increased to about 70 tons.

The Osborn Construction Company, of Chicago, Ill., has been incorporated, the object being general engineering and contracting business; capital stock, $100,000; incorporators, Porter J. Norton, Theodore Burkhard and Judson Lattin.

The Belding Motor and Manufacturing Company has secured ten acres for a site in the manufacturing district between Cragin and Pacific Junction, Chicago, Ill., at the reported cost of $67,000. Three or four hundred men are to be employed.

The Standard Pipe and Foundry Co. has been organized in Cincinnati, with a capital stock of $300,000, to establish pipe works and iron foundry at Radford, Va. J. N. Gamble, of Cincinnati, is president, and W. C. De Armond, vice-president.

S. T. Woodard and others, of New York City, have made a proposition to the Elyton Land Co., Birmingham, Ala., for the drection of a $400,000 steel plant. It is stated that the company will probably subscribe $50,000 to secure the enterprise.

The directors of the Duquesne Tube Works, located at McKeesport, Pa., have decided to erect a large pipe-mill, two additional furnaces and a foundry. The company expects to have the additions completed by the latter part of next spring.

E. H. Watts, of London, England, president of the Watts Steel and Iron Co., now building an iron and steel plant in Middlesborough, Ky., contemplates, it is said, removing to this place from England, a structural iron works plant with a capital of $5,000,000.

Messrs. Zug & Co. (Limited), at their Sable Iron Works, Pittsburgh, Pa., have recently put in operation two new puddling furnaces which were built in the summer. Two others are in course of construction, which will make a total of 42 furnaces at the Sable works.

T. A. Hicks, W. C. Dickey and R. B. Sidell, of Philadelphia, Pa., who lately purchased the rolling-mill, steel plant, machinery, etc., of the Crown and Cumberland Steel Co., at Cumberland, Md., will organize and incorporate under the name of the Cumberland Steel Co.

The Leavitt Machine Company has been formed at Orange, Mass., with W. M. King, president; G. E. Bates, secretary and treasurer; the above and J. B. Farley, and T. E. Leavitt, directors. The company has leased a factory, and will soon begin a general machine business.

Contracts for erecting buildings and furnishing all machinery for the Tredegar Steel Works (P. O. Jacksonville, Ala.,) have been awarded. Work will commence at once, and be pushed as rapidly as possible to completion. The plant will include three furnaces, with daily capacity each of 100 tons, rolling-mill, etc.

It is reported that Lieut. Fitch, formerly superintendent of the Braddock Wire Co.'s mill, at Braddock, Pa., has purchased a plot of ground of about five acres on the Monongahela River, for $20,000. The purchase is said to be for an unknown company, who will manufacture copper wire for telegraph purposes.

The rolling-mill of the Portage Iron Co., at Duncansville, Pa., has been enlarged by the addition of 17 more puddling furnaces, and another train of rolls. The works now contain 37 single puddling furnaces, six heating furnaces, and six trains of rolls. W. G. Merriman is general manager at Duncansville.

The Simmerly Derrick Co., of Cleveland, O., has become an incorporated concern, under the State laws, with an increased capital. The derrick manufactured was invented by A. N. Simmerly, the superintendent of the company, who was for seven years master mechanic of the New York, Lake Erie & Western.

A corporation, to be known as the Haywood Foundry Company has been organized at Portland, Me., for the purpose of carrying on general foundry and machine business. The company has a capital stock of $150,000; its officers are: President, Earl A. Thissel, of Florence, Mass.; treasurer, W. H. Wilder, of Florence, Mass.

The Widdifield Electric Brake Co. has received letters of incorporation from the Ontario government, with Anson T. Button and W. P. Widdifield, of Uxbridge, S. E. Fuller, of Stratford, James Lockhart, S. E. McKinnon, T. R Fuller, and Hugh Blain, of Toronto, charter members; capital stock, $800,000, and head office at Toronto, Can.

The Sharon Steel Casting Co., of Sharon, Pa., are making a number of extensive improvements that will more than double the present capacity of their plant. A new molding-room 100x100 feet is being added, which will give employment to about 20 additional molders. The company make a general line of steel castings in any size from 1 pound up to 15 tons.

The Crosby Steam Gage and Valve Co., Boston, Mass., has issued a very complete illustrated catalogue of specialties made at the works. A good deal of space has been devoted to describing the steam engine indicator and its uses, with the appliances for taking indicator diagrams, measuring them, and making calculations. Engineers will find use for this catalogue.

The Fuel Gas and Manufacturing Co., of Pittsburgh, Pa., has about completed the removal of its machinery from the Twenty-fifth street shops to the works lately vacated by the Westinghouse Air-brake Co., in Allegheny. The new location will give the company an enlarged capacity. A brass foundry will be added, as well as other departments, and the output will be considerably increased.

Brown, Bonnell & Co., of Youngstown, Ohio, have purchased the plant of the Lakeside Nail Co., at Hammond, Ind., and will, it is said, spend $3,000,000 in establishing large iron works, which will give employment to between 2,000 and 2,500 men. The present works, which employ 200 men, will be enlarged by the addition of a plate-mill, a rod-mill, a structural-iron-mill, and a full system of blast furnaces.

A Boston syndicate has decided to locate large car works at Beaumont, Tex., and a company will be organized with a capital stock of $500,000, under the name of the Beaumont Car Works. The citizens of Beaumont subscribed $100,000, besides giving other valuable considerations. Work will begin at once under the supervision of Messrs. Stinson & Moulton, of the National Rolling Stock and Street Car Co., of Boston.

The J. Stevens Arms and Tool Company, of Chicopee Falls, Mass., will put up addition 60x30 feet to its present shop, and has already begun laying the foundation. The new building will be of wood, four stories high, but, with the basement, will give five new floors available for the business of the company. The floor space of the mill will be increased one-third by the addition. New machinery will be put in as the business demands.

Messrs. A. J. Sweeney & Sons, founders and machinists, of Wheeling, W. Va., are said to have made a proposition to invest $100,000 in a wire nail plant at Omaha, Neb., and guarantee to operate it successfully for a period of five years upon certain conditions. They propose to lay out a plan of lots, for which they will ask the Omaha Board of Trade to secure purchasers. As soon as these lots have been taken, they will begin work on the mill.

The Lackawanna Iron and Coal Company at Scranton, Pa., is arranging to perfect extensive improvements at its rolling-mill during the winter, in the shape of a new blooming and billeting train, which will be constructed so as to be used in the manufacture of steel rails, and also four-inch billets of steel, which are used in making wire and rods. A large blower-house will be constructed for additional blowers, and two melting cupolas will be erected.

The contract and the bond for the erection of a $250,000 cotton-mill at Fort Worth, Tex., have been signed, sealed and delivered. The money is in bank, and work was begun, on September 24, on the artesian well to supply the mill with water. To secure this mill, a bonus of $75,000 was given by enterprising citizens. Work on the buildings, which will be of brick, will be commenced at once, and forty houses for the mill operatives will be built in a short time.

The Tucker Manufacturing Company, manufacturers of furniture trimmings and small brass goods, have outgrown their present quarters in Waterville, Conn. They contemplated a removal to some place east of Waterbury, but a few enterprising Waterville people agreed to buy and present to them a lot in Waterville. A $25,000 factory will be erected, which will be leased by the manufacturing company, who will increase their working force to 150 persons.—*Commercial Bulletin.*

The Hughes Steam Pump Co., of Cleveland, O., is now engaged in tripling its capacity for manufacturing steam pumps for water-works, etc., and has recently started machinery in their new machine shops. Work on their buildings was begun on May 1. All work in the machine shop is to be done on the ground floor. This building is 200 feet long by 80 feet wide. The new clearing shop is 60 feet long by 40 feet wide. A 10-ton traveling crane, 30 feet wide, is to run the whole length of the machine shop. A considerable amount of new machinery will soon be put in operation.

W. A. Jones, 11 to 17 South Canal street, Chicago, Ill., issues the following circular to his friends. It explains itself: Having decided to launch out for myself, I have opened in the rear of 11 to 17 South Canal street, and am now in the field to furnish a general line of high grade castings, making a specialty of machine-molded pulleys, from six to thirty-six inches in diameter, varying by inches, and for which I have three sets of arms for each diameter. Having been connected with the Link Belt Machinery Co. as foundry superintendent during the past eight years, together with a practical experience of nearly twenty-five years, warrants me in feeling assured that I can give you thorough satisfaction, should you favor me with a trial order.

The Selection of Emery Wheels.

As every one who has had experience in finishing work by grinding with emery wheels knows, the matter of the proper selection of the wheels for the work to be done is most important, and as the knowledge necessary to do this is usually attained only by long practical experience, we consider that we are doing many of our readers a service by the publication of the following extracts from a pamphlet prepared by the Brown & Sharpe Mfg. Co., and intended to assist in the selection of the wheel best suited to any given job of grinding. Very extended use of grinding machines of various forms at their works give this company much experience upon which the following remarks are based, and though, of course, the prime object of the publication of the pamphlet on their part is to assist in making grinding machines sold by them work most efficiently, and to the best advantage the general principles are, as a matter of course, broadly applicable to the general practice of grinding by emery wheels. The pamphlet is entitled, Emery Wheels, Their Selection and Use,* and after calling attention to the fact that too much should not be expected of one wheel, and commenting upon the importance of selecting the proper wheel for the work to be done, it says:

Our aim in grinding is usually to obtain an accurate or true surface, but as a true surface is almost always a good surface it should be remembered that generally the same methods are employed, whether an exact size or a fine finish is the object desired.

Our suggestions are not offered as positive rules, but as the embodiment of our experience, and as representing the methods which our shop practice has indicated are desirable.

* * * * * *

Wheels are numbered from coarse to fine; that is, a wheel made of No. 60 emery is coarser than one made of No. 100. Within certain limits, and other things being equal, a coarse wheel is less liable to change the temperature of the work and less liable to glaze than a fine wheel. As a rule, the harder the stock the coarser the wheel required to produce a given finish. For example, coarser wheels are required to produce a given surface upon hardened steel than upon soft steel, while finer wheels are required to produce

* Copyright 1890, Brown & Sharpe Mfg. Co.

this surface upon brass or copper than upon either hardened or soft steel.

Wheels are graded from soft to hard and the grade is denoted by the letters of the alphabet, A denoting the softest grade. A wheel is soft or hard chiefly on account of the amount and character of the material combined in its manufacture with emery or corundum. But other characteristics being equal, a wheel that is composed of fine emery is more compact and harder than one made of coarser emery. For instance, a wheel of No. 100 emery, grade B, will be harder than one of No. 60 emery, same grade.

The softness of a wheel is generally its most important characteristic. A soft wheel is less apt to cause a change of temperature in the work, or to become glazed, than a harder one. It is best for grinding hardened steel, cast-iron, brass, copper and rubber, while a harder or more compact wheel is better for grinding soft steel and wrought-iron. As a rule, other things being equal, the harder the stock the softer the wheel required to produce a given finish.

Generally speaking, a wheel should be softer as the surface in contact with the work is increased. For example, a wheel $\frac{1}{16}$ inch face should be harder than one $\frac{1}{2}$ inch face. If a wheel is hard and heats or chatters, it can often be made somewhat more effective by turning off a part of its cutting surface; but it should be clearly understood that while this will sometimes prevent a hard wheel from heating or chattering the work, such a wheel will not prove as economical as one of the full width and proper grade, for it should be borne in mind that the grade should always bear the proper relation to the width.

* * * * *

The quality of the work, as a rule, is improved by using a wheel of full width if the wheel is soft in proportion. Judgment should be exercised in deciding upon the width of wheel to be used, as sometimes the work is of such size and shape as to make it necessary to use a wheel with a narrow face. Where this is the case the wheel should, where strength will admit, be only that width throughout, and care should be taken that the grade is kept in the proper relation to the width.

A wheel is most efficient in grinding just at the point before it ceases to crumble. The faster it is run up to this point the more stock will be removed, and the more economically the work will be produced. Occasionally, however, it is necessary to run a wheel rather slowly, as the more slowly it runs the coarser it cuts and the less likely it is to change the temperature of the work. As a general rule, on any given stock, the softer the wheel the faster it should be run.

Should a wheel heat or glaze it can often be made somewhat more effective by being run more slowly. On the other hand, if it be too soft, it can often be made to somewhat better hold its size and grind straight by being run more rapidly.

The surface speed of the work should be proportionate to the speed of the wheel; that is, other things being equal, if the speed of the wheel is reduced the speed of the work should be reduced also. The desire is to have the work revolve at such a speed as to allow time for the wheel to cut away the high points on the work. If the work is run so fast that there is no time given for the wheel to cut, but the work is simply crowded against the wheel, the tendency is for the wheel to follow the inequalities in the form of the work, and straight or round surfaces are not obtained. When the wheel is not free cutting, and the pressure of the wheel against the work is sufficient to cause the work itself to spring or to cause a slight movement of the oil upon the centers, the accuracy of the result is impaired.

The coarser or softer and more free cutting the wheel the greater can be the speed of the wheel, and consequently of the work. It is, however, not necessary to graduate the speed of the work as closely as the speed of the wheel. The character of the wheel being influenced so readily by a change of speed, it is sometimes essential and often very convenient on universal grinding machines to be able to slightly increase or decrease the speed of the wheel.

* * * * * *

Thus far we have had in mind the selection and use of wheels for the comparatively small or medium sized work ordinarily ground on our machines. The requirements in grinding extremely large or long pieces are somewhat different. For example: In grinding a piece of steel three inches long, one inch diameter, on a universal grinding machine, we have indicated that the most absolutely accurate work would be accomplished by selecting a wheel only just hard enough to retain its size while passing six or eight times over the surface of the piece, and we have suggested that such a wheel should be run at a high rate of speed. We have considered rapidity of production as more important than economy of emery. If, however, we should attempt to use such a wheel to grind a piece of steel one inch diameter and three feet long, it is clear that before the wheel had passed over two of the three feet it would have ceased to cut.

The problem now is to maintain the diameter of the wheel so as to take a uniform cut over a large area. Each particle of emery must be used as long as possible before being thrown away. A wheel full width and full diameter should be used, and the face should be true, so that as many particles as possible may be brought in contact with the work and each particle be dulled as little as possible while the wheel is passing over the work. The particles may be used a longer time, and are not so rapidly thrown away in a hard as in a soft wheel. Accordingly, one expedient in grinding large areas is to use harder wheels as the area of the work increases, the speed of the wheels being reduced as the grade is increased.

The loss of fine particles will not decrease the diameter of the wheel as rapidly as the loss of coarser or larger particles. Thus another expedient is to use a finer wheel. A fine wheel can be relatively softer than a coarser wheel, and so with a fine one there need be less pressure between the wheel and the work, and there is more certainty of obtaining an accurate surface.

As the length or area of the work increases the feed should be coarser, so that the wheel may travel the entire length or area of the piece while its diameter is practically unchanged.

Water should be used on such classes of work as are injuriously affected by a change in temperature caused by grinding. It should be used upon work revolved upon centers, as in this work a slight change of temperature will cause the wheel to cut on one side of the piece, after it has been ground apparently round.

In very accurate grinding it should be remembered that the exactness of the work will be affected by a change in temperature which is not perceptible to the touch.

In very accurate grinding it is also well to use the water over and over again, as by so doing there is less difference between the temperature of the water and that of the work than if fresh water is used. For many purposes soda water is the most satisfactory, as it has less tendency to rust the work or the machine.

* * * * * *

Water need not be used on work held in the head-stock spindle on universal grinding machines, such as saws, collars, boxes, etc., with wheels given in the list.

Cast-iron plates are an exception to this rule. They require a large supply of water with slow wheel speed when ground with the wheels specified in the list.

For internal grinding it is especially important that a wheel should be free cutting, and the work revolved so slowly as to enable the wheel to readily do its work. The wheels should generally be softer than for external grinding, as a much larger portion of the periphery is in contact with the work. Their small diameters make it impossible for the proper periphery speed to be obtained, and this must be considered in regulating the speed of the work.

The points given above are summarized as follows:

Soft free cutting wheels, such as are made by a number of the companies using the vitrified process, are the best for most purposes. The ideal wheel is the one composed entirely of cutting materials. The width of the wheel should be in proportion to the amount of stock to be removed at each revolution. The wheel should be soft in proportion to the surface in contact with the work. The speed of the wheel should be in proportion to its softness, and the speed of the work should be in proportion to the speed of the wheel.

Then follow specific rules and directions for the selection of wheels by grade and number, which we do not quote, our extracts being confined to that part of the pamphlet in which general principles are treated.

The Naphtha Launch "Lancet."

Amongst the many busy business and professional men in this vicinity who spend a little time on the water to the end of recreation is Dr. P. J. McCourt, of New York. The doctor has recently had built for him a steam launch, which—sticking to the last, but with no overt intentions—has been christened the "Lancet," and which he proposes to use during the warm months of the summer for pleasure purposes.

The "Lancet" was built by Frank W. Ofeldt, of Brooklyn, and is designed for outside work when it is desired. She is 40 feet long, 7½ feet beam, and is fitted with a compound trunk engine having a single cylinder 10″x9″; this establishes the size of the low-pressure cylinder, while the trunk makes the high-pressure cylinder the equivalent of a cylinder 5½ inches diameter.

The engine drives a four-bladed propeller 30 inches diameter and 45 inches pitch, the normal turns of the engine being 275 per minute, giving a speed of about ten miles per hour.

The boiler is of the "coil" type, the vertical coils surrounding a central stand pipe, with which they are connected at the top and bottom. Steam can be generated ready for running in five minutes, and the boiler is tested to a pressure of 900 pounds, and designed to work at 200 pounds.

The expression "naphtha launch" might be misleading unless qualified. The engine of the "Lancet" is not of that type in which naphtha gas is used as a working fluid; on the contrary, in the "Lancet," naphtha gas is burned as fuel for the production of steam from water, the engine being no more nor less than a compound trunk engine, the boiler being fed for fuel with naphtha gas.

The naphtha from which the gas is generated is stored in a tank in the bow of the launch; this tank is surrounded by water, cutting off any possible communication with the boat. A pump driven from the main engine supplies the naphtha to the vaporizer, near the engine, where it is vaporized by steam heat, no fire coming in contact with the pipe in any shape. Furthermore, as a precautionary measure, the pipe from the naphtha tank passes down to the keel, and thence under water to the engine. The precautions taken seem to render the use of naphtha fuel entirely safe. The naphtha tank will hold sufficient fuel for a run of from 600 to 700 miles.

The "Lancet" has now gone into winter quarters, to appear in the spring completely fitted for service. Dr. McCourt has found time in his life to graduate from a school of navigation, and has full papers entitling him to run his launch anywhere, and she will come out in the spring fitted with all the implements carried by a sea-going steamship, and will get a taste of outside work.

It may be said, in passing, that the "Lancet" appears to keep top of a sea like a life buoy, and there is no reason to believe that her passengers will be seriously incommoded by any ordinary freaks of wind and water. She is fitted with all arrangements for cooking, has fresh water compartments, ice lockers, and every convenience for a pleasant summer trip. Of course this means that the small space at command has been thoroughly utilized, but there appears to be plenty of room. This is helped, in part, by the small space required for the boiler and engine, the total weight of the machinery, developing more than twenty horse-power, being only about 1,600 pounds.

Balanced Slide Valves.

BY BELL CRANK.

THIRD PAPER.

Balanced slide valves may be properly divided into two classes, viz., steam balanced and positive balanced. To the latter class belong all those valves which are fitted to an orifice enclosed by solid walls of metal, such as the piston valve, and the rectangular open valve with pressure plate. This is the only class of slide valves that actually are perfectly balanced.

The piston valve is too well known to need any description, but it may be noted that it has two features in its construction, that enable it to be made one of the most perfectly balanced valves that can be constructed. The cylindrical walls that enclose it, and the same shape for the valve, make it the best form to get a uniform expansion of the metal due to heat, and with the least weight of metal gives the greatest strength to withstand the distorting effect of steam pressure.

The thin rectangular frame valve with pressure plate is not much distorted by pressure or heat, from the fact that the valve is free to expand both in length and width, without touching anything, and it is thin enough so there can be no harmful variation of thickness from unequal expansion. The pressure plate is made heavy enough to withstand the pressure without changing its form, and is shaped of as uniform section as possible, so the expansion due to heat will not distort it. To make this valve perfectly balanced, the pockets or false ports in the pressure plate must at all times be in free communication with the corresponding cylinder ports.

Neither of the above valves are self-adjusting to wear, and in some of them the pressure plate is bolted down so the valve cannot lift it off the seat in case water gets in the cylinder.

Attempts have been made to steam balance the pressure plate by having attached to it a piston or a diaphragm, against which the steam pressure would act to balance part of the downward pressure, but there is no advantage gained by it, for the reason that the equilibrium area of the balance ring can only be about the same size as for a simple slide valve, and there is the friction of two surfaces to overcome, which would be just double that of a simple ring balanced slide valve of equal size.

I know of an engine running in a large factory, the valve of which was called a balanced valve, but it is a simple D slide valve, with the back made a plain flat surface, and a plain flat adjustable plate against the back of it. There are no ports or apertures of any kind in the plate or back of the valve, and it is kept adjusted close as can be without binding the valve. How the man who designed it ever expected to keep the pressure from accumulating between the plate and the valve (when it would then be just the same as a plain D valve) is more than I can imagine. I was not surprised to learn they had great trouble with the rock-arms getting loose or breaking.

Two other shapes of positive balanced valves, the square, and a triangular made by dividing a square through the corners, have been used. The square valve is simply a square piston valve, and is fitted up by enveloping half of it with a cover of triangular shape. This valve has one feature that is an advantage—the cover can be adjusted to take up the wear. It requires great care in designing this valve to make it so that it will not be distorted by the heat and pressure, and it is likely to prove an entire failure on large engines. Much the same must be said of the triangular shape, only that it is worse affected by unequal expansion than the square one is.

Another form of nearly balanced valve is the wedge or half V shape section, the angle being usually somewhere near ten degrees. It is kept from being wedged between the seats by resting on flanges at the wide end, or the narrow edge rides on a bearing. These valves do very well on small engines, but when applied to large ones it is found that trouble arises from unequal expansion and distortion of shape by pressure, causing them to work hard, and cut so they wear out of shape and leak. It may be possible to design one that would work well on a large engine, but scarcely any designer would be willing to make it heavy enough to keep the pressure from deflecting it, and unless that is done it would be an experiment of considerable risk. This refers only to a valve which both admits and exhausts steam, for a gridiron valve of inverted V shape has been used with success where it has served as an admission or exhaust valve alone.

The gridiron valve is not balanced, but by using a separate valve for admission and exhaust, the D opening is dispensed with, and the only unbalanced moment is while the valve is covering the port; for as soon as it opens the port it is perfectly balanced, and remains so until it again covers it.

There is a host of different valves I have not mentioned, but I have endeavored to discuss about all the slide valves that had promising features to recommend them.

In a letter from the inventor of the balance ring shown in Fig. 4, second paper, he writes that no springs are needed to hold the ring up against the cover, if the outside ring, when it drops down, still projects above the ring turned on the back of the valve; for as soon as steam is turned on it will immediately float or lift the ring up to the cover. The outside ring must be an easy turning fit on the valve ring.

Under the title of "Electrical Pranks," a recent number of *The Engineer* notes some peculiar facts as to the effect of high tension currents for power and light purposes on telephone and telegraph lines. If two wires are stretched side by side but not touching, a current sent through one of them will cause a current to flow in the opposite direction through the other as long as the first current is fluctuating. When this current becomes steady, however, all the inductive effect in the second wire disappears and no current flows. The majority of the dynamos now in use are alternating, or generators of currents whose electromotive force alternately rises and falls. A current from such a machine is constantly fluctuating, and, consequently, always tends to set up induced currents in other wires.

It is said to be an actual fact that one of our new naval cruisers recently got into collision with another vessel without being sunk. This shows encouraging improvement.

Italian manufacturers have officially declared that it would be a waste of time and money for them to exhibit at the Chicago World's Fair.

Machinists' Supplies and Iron.

NEW YORK, November 1, 1890.

Iron—American Pig—Aside from the product which is absorbed by standing contracts, the trading is confined almost entirely to that which is needed to supply the current requirements of consumers, who generally show very little disposition to purchase beyond this.

Prices of the standard brands are well maintained but occasional concessions are obtained on other brands, resulting chiefly from the pressure of new furnaces to make sales in competition with those who have an established trade and reputation.

We quote No. 1 Foundry, standard Northern brands, $17 to $18; No. 2, $16 to $16.50; Southern brands No. 1 Foundry, $16 to $17; No. 2, $15.75 to $16.

Scotch Pig—The primary market has ruled steady, and the general situation both there and here has been quiet, the trading having been confined to small lots.

We quote Coltness, $24.50; Dalmellington, $22 to $22.50, and Eglinton, $20.50.

Bar Iron—No change of importance has taken place.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2.00 for round lots on dock.

Plate—The general condition of the market remains about the same, with production and consumption about evenly balanced.

We quote Common Tank, $2.25 to $2.30; Refined, $2.35 to $2.45; Shell, $2.35 to $2.45; Flange, $3.40 to $3.45; Extra Flange, $3.60 to $3.75.

Lead—The demand has been quite light, and values are nominal.

For prompt and near delivery prices are 5.75c. to 6c.

Spelter—The offerings have been light and the demand moderate, with prices firmly held.

Western for prompt delivery has been sold at 6c. to 6¼c.

We quote ordinary brands of Western at 6c. to 6⅛c.; choice, 6⅛c. to 6¼c.; refined, 7¾c. to 8c.; Silesian, 7⅞c. to 7½c.

Tin—Trade has been quiet, and the market has ruled fairly steady. Prices are at about 21.65c. to 21.75c.

Antimony—The demand for Regulus has been moderate.

We quote Hallett's at 18¾c. to 19c.; L. X., 20¾c., and Cookson's at 21¼c. to 21½c.

Copper—The demand has increased somewhat, consumers showing more disposition to lay in a stock beyond immediate requirements. Large sales, of Lake are reported at 17c. Common casting brands are also in somewhat better demand, and are steady at 14¼c., Arizona, 15¼c. to 15⅜c.

Lard Oil—The demand has been fairly good, especially for Prime, the prices of which remain at 50½c. to 51c.

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Wanted—Position as practical draftsman. C. W. L., Farmington Avenue Hotel, Hartford, Conn.

Engineer and salesman wants position. Steam pumping machinery specialty. Box 102, AM. MACH.

Wanted at Once—Six good general machinists; apply in person if possible. Taunton Locomotive Mfg. Co., Taunton, Mass.

Foreman wanted for machine shop, to handle about 75 machinists to advantage. Address B 2, AMERICAN MACHINIST.

Wanted—Situation as foreman boiler maker; 25 years' experience; strictly temperate; good references. Address B. M., 749 Porter st., Detroit, Mich.

Wanted—12 first-rate tool makers, for work on gun fixtures, tools and gauges. The Pratt & Whitney Co., Hartford, Conn.

A mechanical draftsman with several years' exp. especially in building steam engines, desires position. Good references. M. D., AM. MACHINIST.

We have a good opening for a young man just out of his time, as pattern maker, to advance himself. Address Box 99, AMERICAN MACHINIST.

Wanted—A blacksmith who understands tool dressing and machine forging; married man preferred. Box 98, AMERICAN MACHINIST.

Exp'd milling mach. hand, 6 years on Brown & Sharpe No. 3 Universal M. M., wishes to correspond with reliable parties. Miller, AM. MACHINIST.

Wanted—Position as foreman of shop making fine tools or light machinery. A1 reference. Address Box 103, AMERICAN MACHINIST.

Wanted—Men to erect turret lathes. Good pay and steady work to experienced men. Gisholt Machine Co., Madison, Wis.

Wanted—Practical machinist, with some money, to take an interest in and charge of established paying shops. Address, with reference, L. M. Newbury, Sparta, Wis.

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Wanted—An assistant foreman, capable of handling seventy-five men on steel pipe. Must be a pushing, energetic man; reference required. Apply to East Jersey Pipe Works, Paterson, N. J.

Wanted—A competent layer out who is familiar with pipe and furnace work; no other need apply; reference required. Apply to East Jersey Pipe Works, Paterson, N. J.

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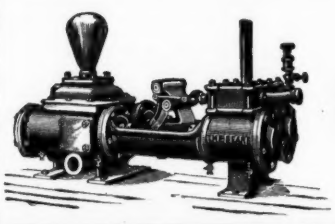

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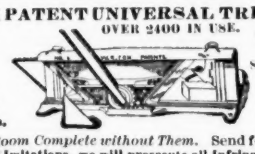

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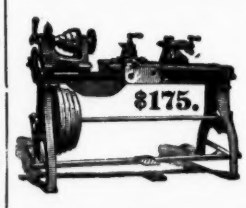

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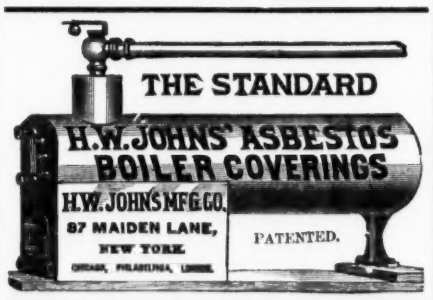

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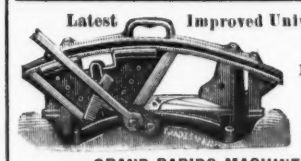

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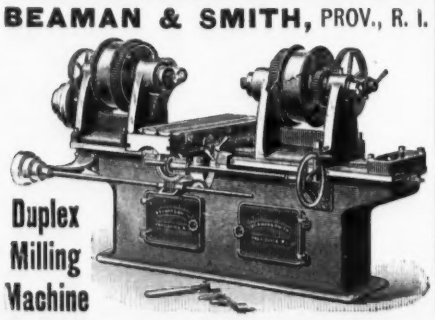

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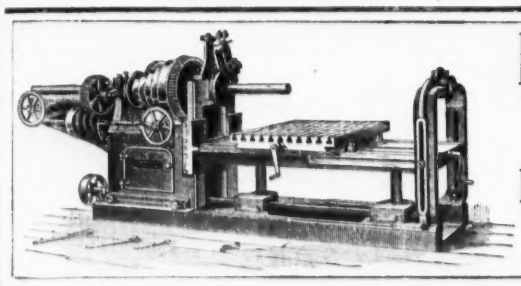

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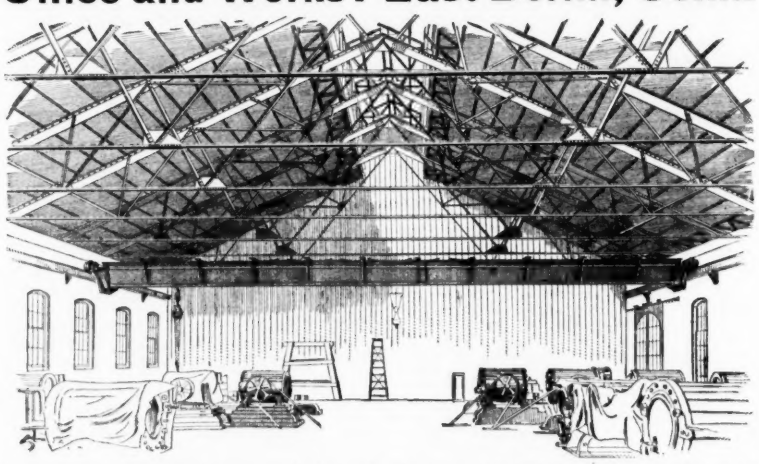

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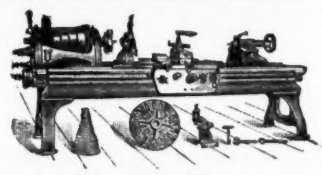

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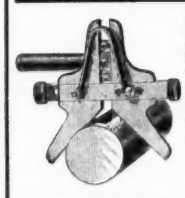

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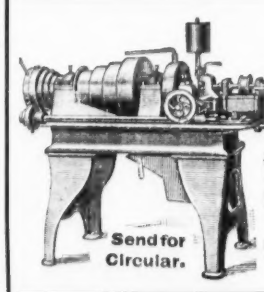

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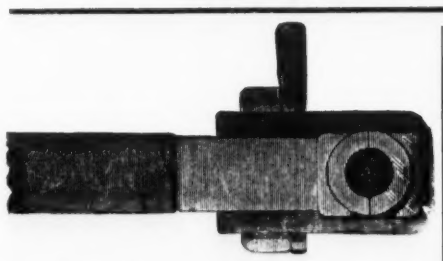

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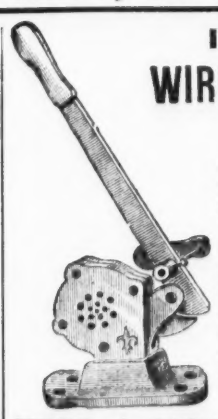

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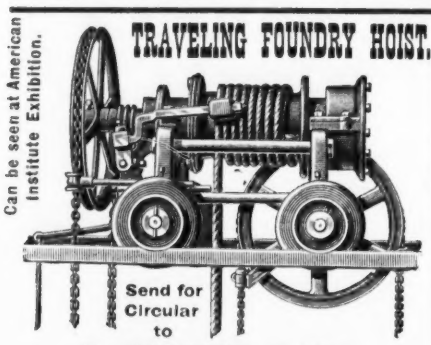

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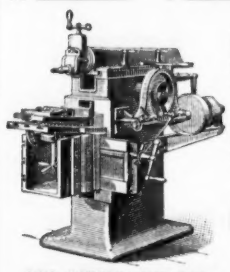

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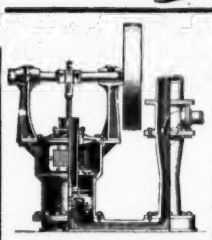

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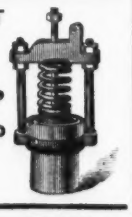

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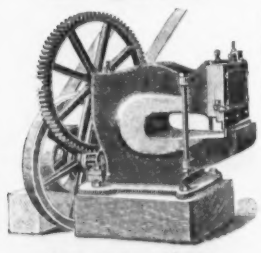

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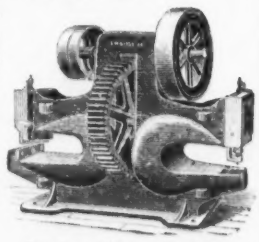

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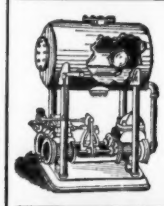

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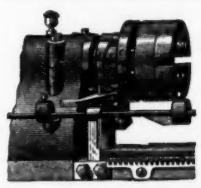

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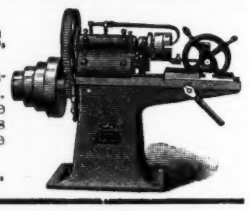

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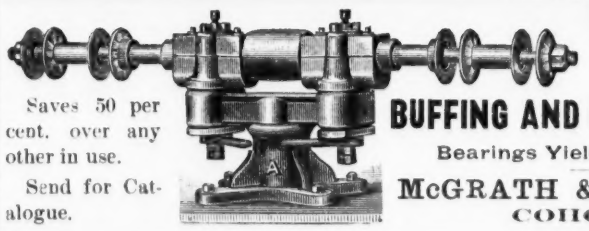

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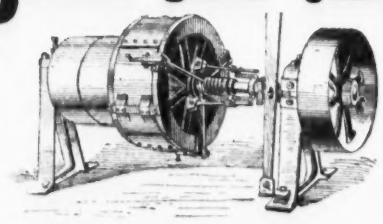

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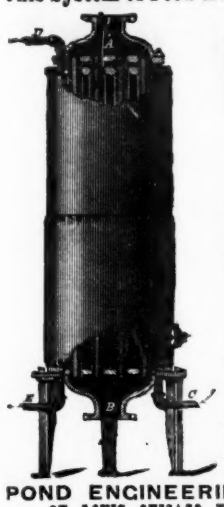

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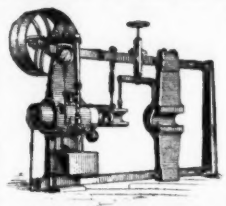

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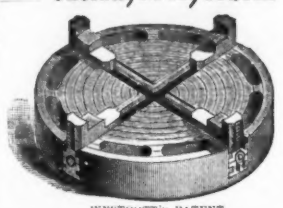

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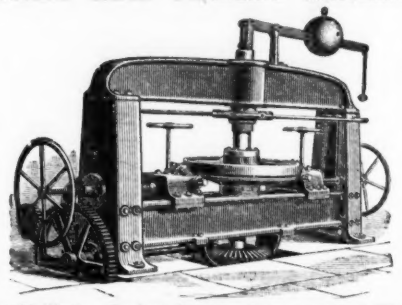

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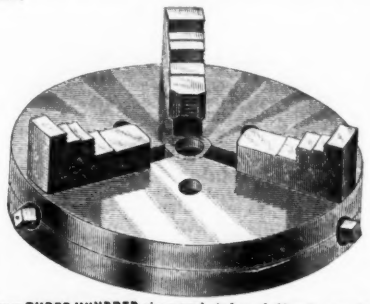

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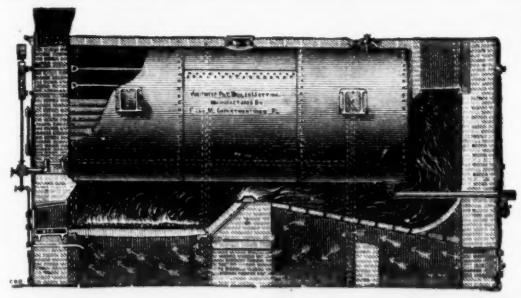

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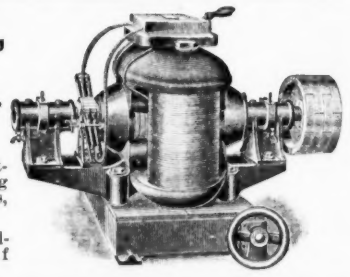

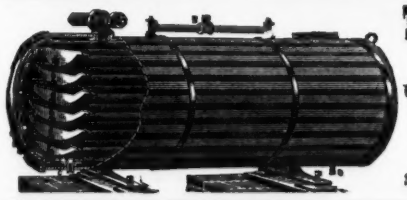

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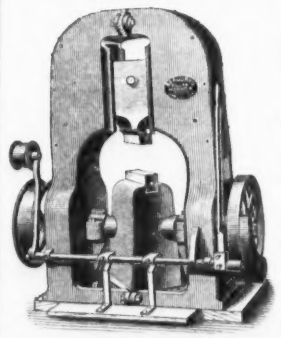

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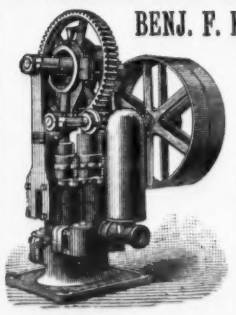

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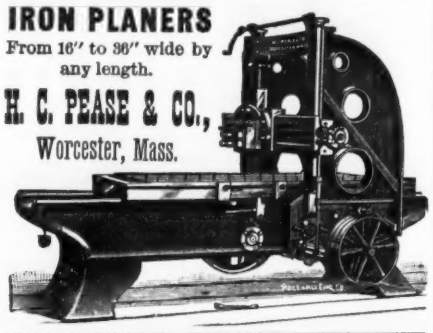

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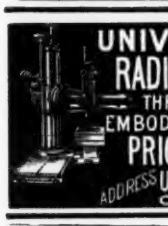

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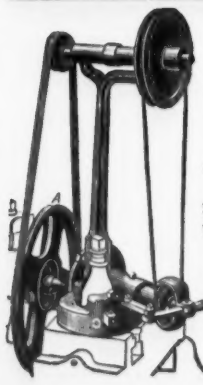

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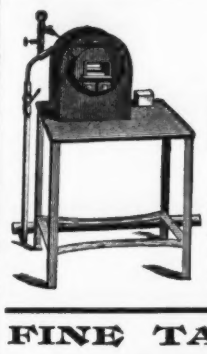

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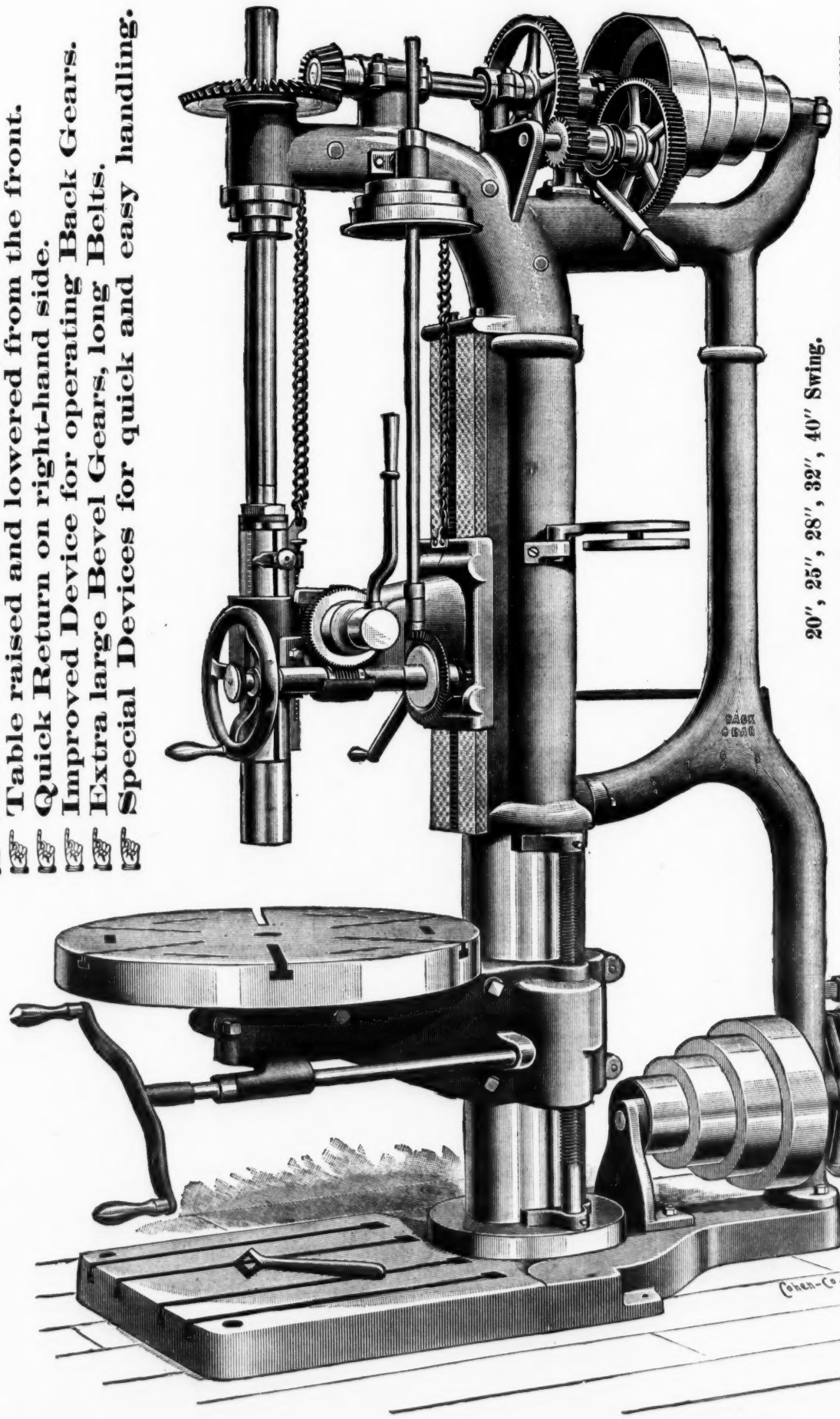

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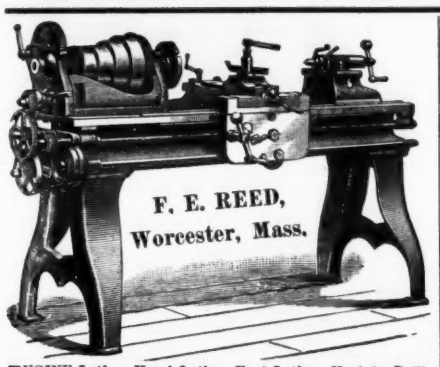

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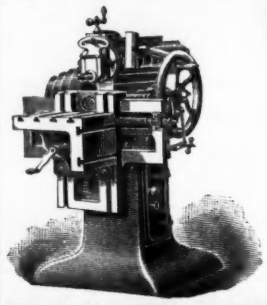

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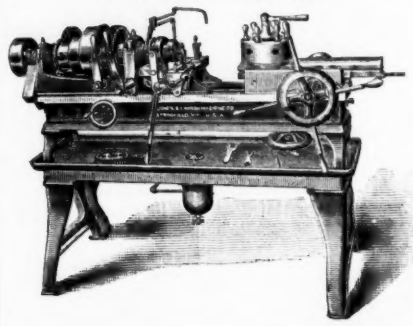

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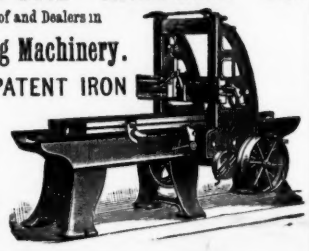

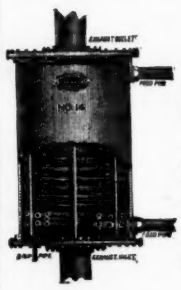

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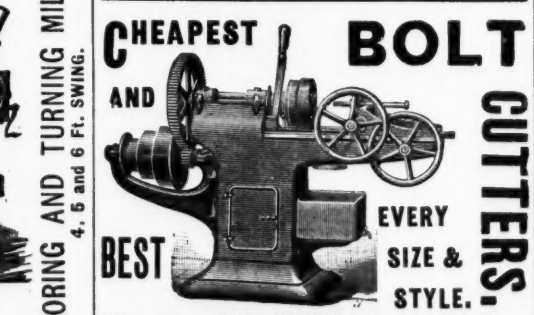

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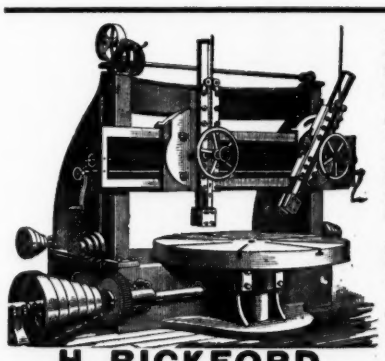

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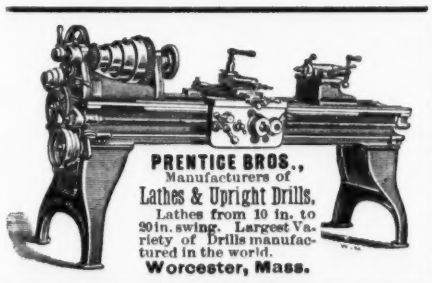

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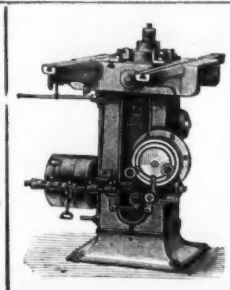

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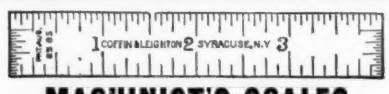

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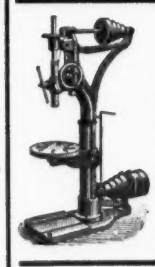

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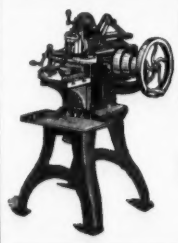

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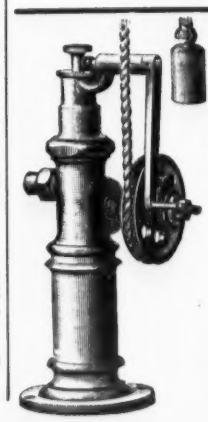

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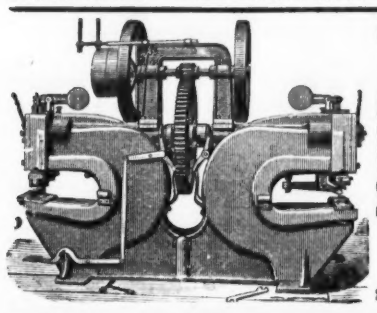

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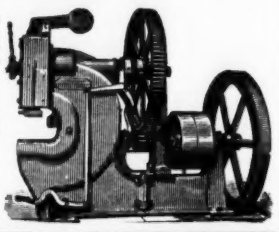

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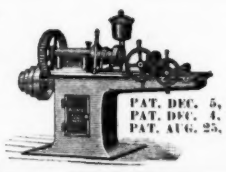
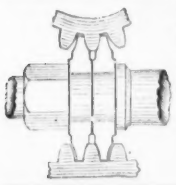


PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.



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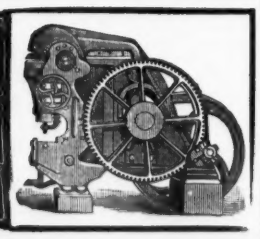

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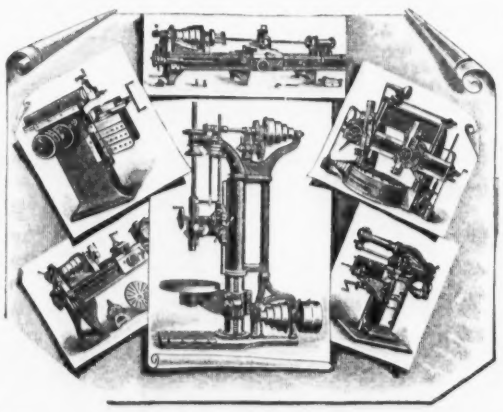

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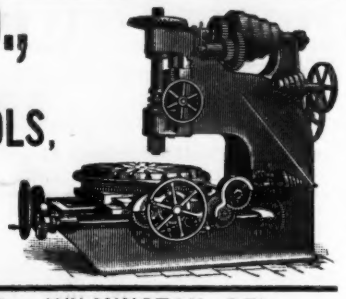

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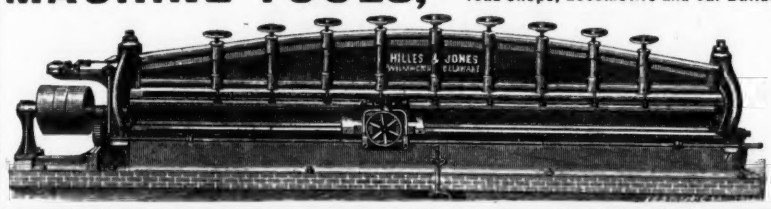

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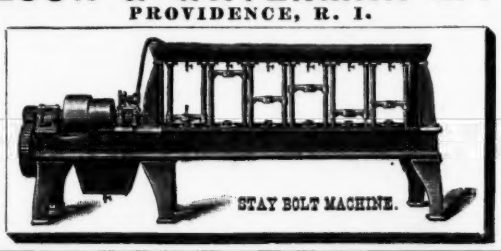

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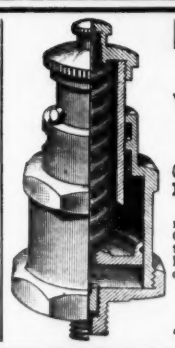

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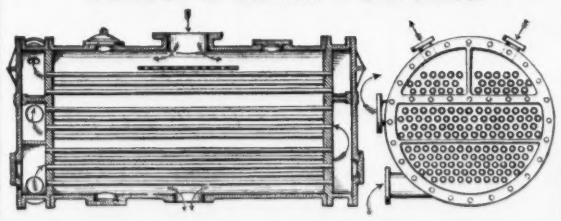

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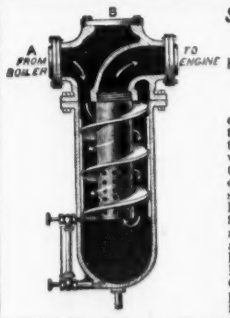

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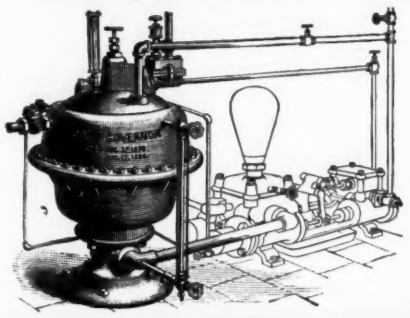

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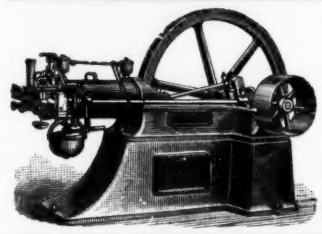

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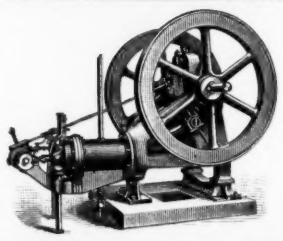

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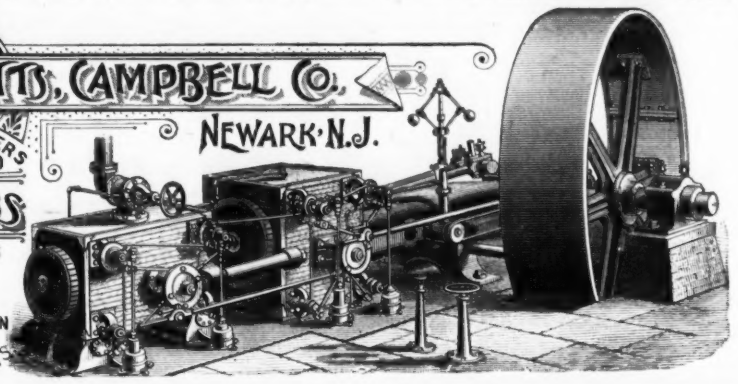

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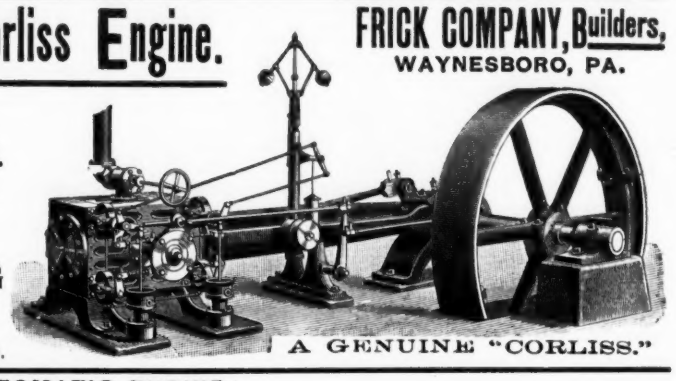

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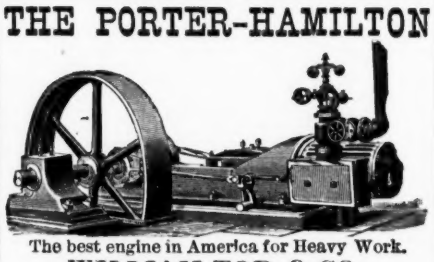

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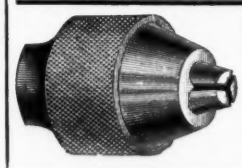

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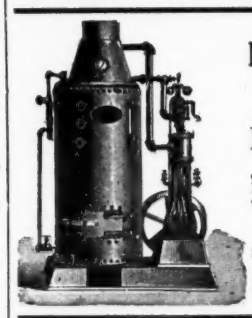

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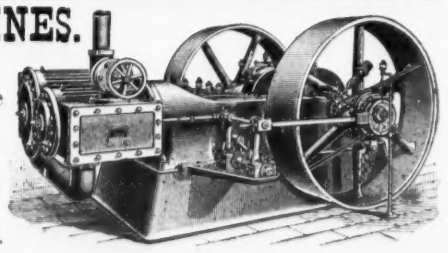

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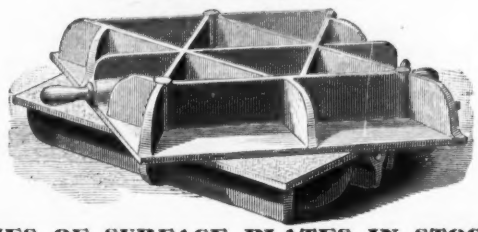

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6 × 12″	"	19 "	10 × 30″	"	99 "	20 × 78″	"	813 "
6 × 50″	"	120 "	12 × 12″	"	29 "	24 × 24″	"	164 "
6½ × 18″	"	30 "	12 × 18″	"	53 "	24 × 36″	"	298 "
7 × 7½″	"	11 "	14 × 14″	"	47 "	24 × 48″	"	442 "
7 × 10″	"	15 "	14 × 18″	"	62 "	24 × 60″	"	666 "
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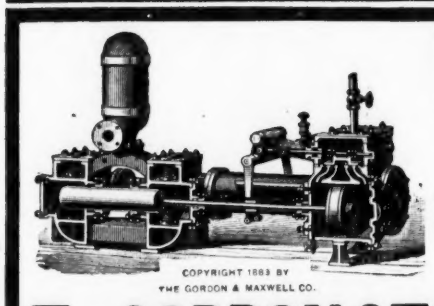

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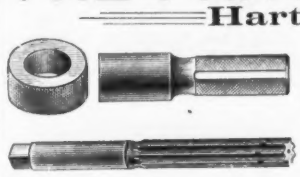

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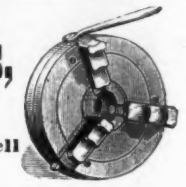

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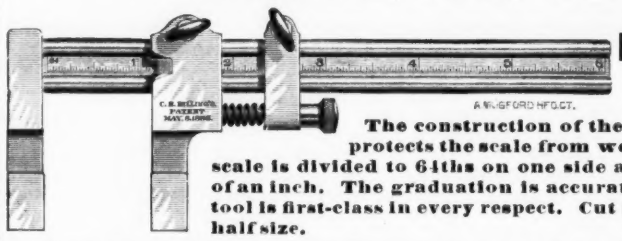

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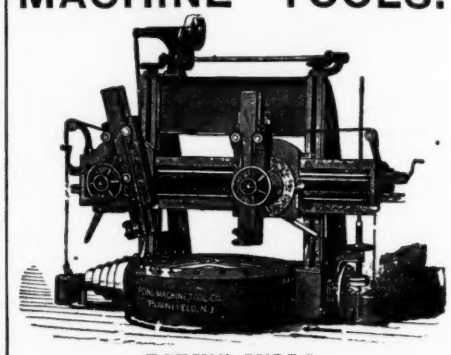

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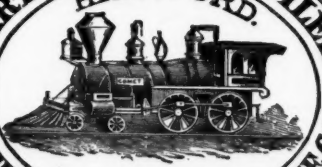

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